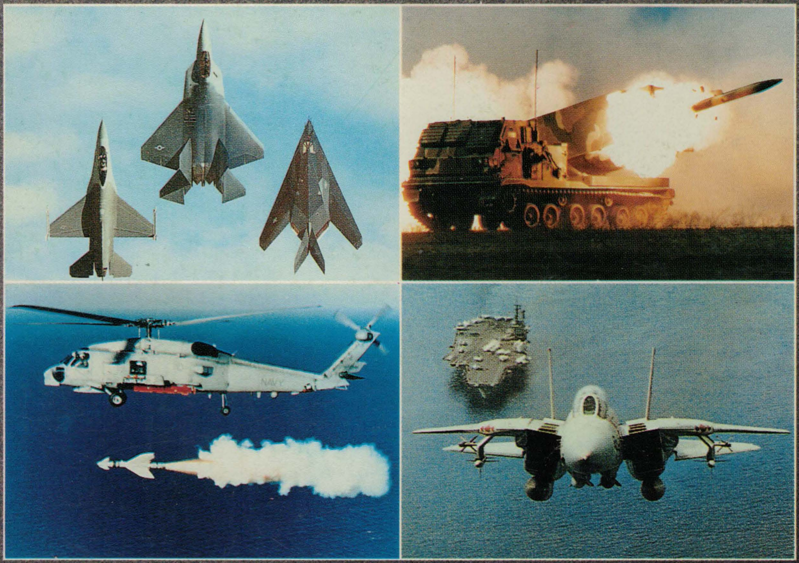
1994-95

ANALOG MILITARY DATA BOOK SUPPLEMENT

HARRIS

DB 312



# ANALOG MILITARY DATA BOOK SUPPLEMENT

# 1994-95

HARRIS

SEMICONDUCTOR

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HARRIS SEMICONDUCTOR

# HARRIS SEMICONDUCTOR

The 1994 Military Data Book Supplement, combined with the 1989 Analog Military Product Data Book, contains detailed technical information on the extensive line of Harris Semiconductor Linear and Data Acquisition products for Military (MIL-STD-883, DESC SMD and JAN) applications and supersedes all previously published Linear and Data Acquisition Military data books. For applications requiring Radiation Hardened products, please refer to the 1993 Harris Radiation Hardened Product Data Book (#DB235B).

For complete, current and detailed technical specifications on any Harris devices please contact the nearest Harris sales, representative or distributor office. Literature requests may also be directed to:

**Harris Semiconductor Literature Department**
**P.O. Box 883, MS CB1-25**
**Melbourne, FL 32901**
**TEL: 1-800-442-7747**
**FAX: (407) 724-3937**

**See Section 13 for Data Sheets Available on AnswerFAX**

**U.S. HEADQUARTERS**
Harris Semiconductor
1301 Woody Burke Road
Melbourne, Florida 32902
TEL: (407) 724-7000

**SOUTH ASIA**
Harris Semiconductor H.K. Ltd
13/F Fourseas Building
208-212 Nathan Road
Tsimshatsui, Kowloon
Hong Kong
TEL: 852-723-6339

**EUROPEAN HEADQUARTERS**
Harris Semiconductor
Mercure Centre
100, Rue de la Fusee
1130 Brussels, Belgium
TEL: 32 2 724 21 11

**NORTH ASIA**
Harris K.K.
Shinjuku NS Bldg. Box 6153
2-4-1 Nishi-Shinjuku
Shinjuku-ku, Tokyo 163 Japan
TEL: 81-3-3345-8911

See our specs in CAPS

# ABOUT THIS DATA BOOK

Harris Semiconductor is an industry leader in developing and producing advanced Linear and Data Acquisition products for demanding Military applications.

The 1994 Military Data Book Supplement includes: datasheets for Harris Military products introduced or significantly changed since the publication of the attached 1989 Analog Military Product Data Book, new die plots for products that have been redesigned since the 1989 data book and the addition of "Harris AnswerFAX - Data Sheets by FAX". AnswerFAX is the Harris automated response system that gives you access to a full library of the latest complete data sheets, application notes and other information on Harris products. The 1994 Military Data Book Supplement includes shortened version /883 Military product data sheets containing Table 1, 2, and 3 data only. For complete Military /883 product data sheets please use the Harris AnswerFAX system and request documents using the file number listed on page one of every Harris data sheet. In addition, a listing of SPICE Models and product Packaging data provides a wide variety of information at your fingertips.

It is our intention to provide you with the most up-to-date information on Linear and Data Acquisition Military products. For complete, current and detailed technical specifications on any Harris devices, please contact the nearest Harris sales, representative or distributor office listed at the back of the data book; or direct literature requests to:


**Harris Semiconductor Literature Department**
**P.O. Box 883, MS CB1-25**
**Melbourne, FL 32901**
**1-800-442-7747**
**FAX 407-724-3937**


**See Section 13 for Data Sheets Available on AnswerFAX**

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*Harris Semiconductor products are sold by description only. All specifications in this product guide are applicable only to packaged products; specifications for die are available upon request. Harris reserves the right to make changes in circuit design, specifications and other information at any time without prior notice. Accordingly, the reader is cautioned to verify that information in this publication is current before placing orders. Reference to products of other manufacturers are solely for convenience of comparison and do not imply total equivalency of design, performance, or otherwise.*

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HARRIS
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# ANALOG 1994 MILITARY DATABOOK SUPPLEMENT

# TECHNICAL ASSISTANCE

For technical assistance on the Harris products listed in this databook, please contact the Field Applications Engineering staff available at one of the following Harris Sales Offices:


**UNITED STATES**

| | | |
|---|---|---|
| CALIFORNIA | Costa Mesa | 714-433-0600 |
| | San Jose | 408-995-7322 |
| | Woodland Hills | 818-992-0686 |
| FLORIDA | Melbourne | 407-724-3576 |
| GEORGIA | Duluth | 404-476-2033 |
| ILLINOIS | Schaumburg | 708-240-3480 |
| INDIANA | Carmel | 317-843-5180 |
| MASSACHUSETTS | Burlington | 617-221-1850 |
| NEW JERSEY | Voorhees | 609-751-3425 |
| NEW YORK | Great Neck | 516-829-9441 |
| TEXAS | Dallas | 214-733-0800 |

**INTERNATIONAL**

| | | |
|---|---|---|
| FRANCE | Paris | 33-1-346-54046 |
| GERMANY | Munich | 49-89-63813-0 |
| HONG KONG | Kowloon | 852-723-6339 |
| ITALY | Milano | 39-2-262-0761 |
| JAPAN | Tokyo | 81-33-345-8911 |
| KOREA | Seoul | 82-2-551-0931 |
| SINGAPORE | Singapore | 65-291-0203 |
| UNITED KINGDOM | Camberley | 44-2-766-86886 |
| TAIWAN | Taipei | 886-2-716-9310 |

For literature requests, please contact Harris at 407-724-3739.

# ANALOG 1

## GENERAL INFORMATION



## ALPHA NUMERIC PRODUCT INDEX

# ALPHA NUMERIC PRODUCT INDEX (Continued)

# ALPHA NUMERIC PRODUCT INDEX (Continued)

# ALPHA NUMERIC PRODUCT INDEX (Continued)

# ALPHA NUMERIC PRODUCT INDEX (Continued)

# PRODUCT INDEX BY FAMILY

## CMOS ANALOG SWITCHES

# PRODUCT INDEX BY FAMILY (Continued)

## OPERATIONAL AMPLIFIERS (Continued)

# PRODUCT INDEX BY FAMILY (Continued)

# ANALOG 2

## MILITARY PROGRAMS

# Harris Military Grade Levels

MIL-STD-883 describes several levels or "grades" of screening for microcircuits. Although basic circuit design and manufacturing process technology may be identical, differences in testing, documentation, and product assurance criteria are designed to guarantee the needed reliability levels for a particular application. Harris offers two basic levels of standard products.

| MILITARY GRADE | APPLICATION |
|---|---|
| Class S | Spacecraft and other "Hi-Rel" systems which require long term reliability in a harsh environment. Applications are frequently life-critical and component replacement is costly or impossible. Harris class S or equivalent product is used in military, commercial, and scientific satellite systems as well as medical implantible and nuclear powerplant applications. |
| Class B | Military Systems for harsh applications requiring performance over an extended temperature range. Harris class B and equivalent product is used in aerospace, strategic, tactical, and secure communications systems as well as low priority space and commercial aircraft applications. |

# Military Grade Product Offerings

Harris military grade product is offered in the following levels. For detailed process flows and specific quality and reliability information, refer to section 10.

- **JAN - JOINT ARMY NAVY**

  (Indicated by DESC Issued "Slash Sheet" Number)

  Fully compliant to MIL-I-38535. Changes must be approved by DESC who also maintains a continuing audit of manufacturing compliance (class S and class B).

- **SMD - STANDARD MICROCIRCUIT DRAWING**

  (Indicated by DESC Part Number)

  Fully compliant to MIL-STD-883. Major changes must be approved by DESC (currently applies to class B only).

- **HARRIS CLASS B COMPLIANT**

  (Indicated by /883 or /883B Suffix on Harris Part Number)

  Fully compliant to MIL-STD-883 Paragraph 1.2.1.

- **HARRIS CLASS B "EQUIVALENT"**

  (Indicated by -8 Suffix on Harris Part Number)

  Exceptions to MIL-STD-883 per individual data sheet.

- **HARRIS CLASS S "EQUIVALENT"**

  (Indicated by -Q Suffix on Harris Part Number)

  Exceptions to MIL-STD-883 per individual data sheet.

# Non-Standard Product Offerings

Harris understands the need for customer generated Source Control Drawings (SCDs) with non-standard parameter and/or screening requirements. A Customer Engineering Department is responsible for efficiently expediting your SCDs through a comprehensive review process. The Customer Engineering Group compares your SCD to its closest equivalent grade device type and works closely with the Product Engineer, Manufacturing Engineer, Design Engineer, or applicable individual to compare Harris' screening ability against your non-standard requirement(s). For product processed to non-standard requirements, a unique part number suffix is assigned.

Harris shares the military's objective to utilize standards wherever possible. We recommend using our /883 data sheet as the guideline for your SCD's. In instances where an available military specification or Harris /883 datasheet is inappropriate, it is Harris' sincerest wish to work closely with the buyer in establishing an acceptable procurement document. For this reason, the customer is requested to contact the nearest Harris Sales Office or Representative before finalizing the Source Control Drawing. Harris looks forward to working with the customer prior to implementation of the formal drawing so that both parties may create a mutually acceptable procurement document.

# Harris Analog/DSP Military Part Number Listing

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| DG181AA/883B | | | - |
| DG181AP/883B | | | - |
| DG182AA/883B | | | - |
| DG182AP/883B | | | - |
| DG184AP/883B | | | - |
| DG185AP/883B | | | - |
| DG187AA/883B | | | - |
| DG187AP/883B | | | - |
| DG188AA/883B | | | - |
| DG188AP/883B | | | - |
| DG190AP/883B | | | - |
| DG191AP/883B | | | - |
| DG200AA/883B | | | - |
| DG200AK/883B | | | - |
| DG201AAK/883B | 7705301EA | /12302BEA | 3117 |
| DG201AK/883B | | | - |
| DG202AK/883B | | | - |
| DG300AAA/883B | | | - |
| DG300AAK/883B | | | - |
| DG300AAP | | /11601BCA | - |
| DG301AAA/883B | | | - |
| DG301AAK/883B | | | - |
| DG301AAP | | /11602BCA | 3119 |
| DG302AAK/883B | | | 3119 |
| DG302AAP | | /11603BCA | 3119 |
| DG303AAK/883B | | | 3119 |
| DG303AAP | | /11604BCA | 3119 |
| DG308AAK/883B | | | - |
| DG309AAK/883B | | | - |
| DG401AK/883 | 5962-9056901EA | | 3703 |
| DG403AK/883 | 5962-8976301MEA | | 3703 |
| DG405AK/883 | 5962-8996101EA | | 3703 |
| DG406AK/883 | | | 3720 |
| DG407AK/883 | | | 3720 |
| DG408AK/883 | 5962-9204201MEA | | 3688 |
| DG409AK/883 | 5962-9204202MEA | | 3688 |
| DG411AK/883 | 5962-9073101MEA | | 3681 |
| DG412AK/883 | 5962-9073102MEA | | 3681 |
| DG413AK/883 | 5962-9073103MEA | | 3681 |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

## *Harris Analog/DSP Military Part Number Listing* (Continued)

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| DG441AK/883 | 5962-9204101MEA | | 3687 |
| DG442AK/883 | 5962-9204102MEA | | 3687 |
| DG458AK/883 | | | 3708 |
| DG459AK/883 | | | 3708 |
| DG506AAK/883B | | | - |
| DG507AAK/883B | | | - |
| DG508AAK/883B | | | - |
| DG509AAK/883B | | | - |
| DG526AK/883B | | | - |
| DG527AK/883B | | | - |
| DG528AK/883B | | | - |
| DG529AK/883B | | | - |
| HA1-2400/883 | 5962-8778301EA | | 3926 |
| HA4-2400/883 | 5962-87783012A | | 3926 |
| HA1-2420/883 | 8001601CA | | - |
| HA4-2420/883 | 80016012A | | - |
| HA1-2444/883 | 5962-9309501MEA | | 3608 |
| HA2-2500/883 | | /12204BGA | 3734 |
| HA7-2500/883 | | /12204BPA | 3734 |
| HA2-2502/883 | | | 3734 |
| HA4-2502/883 | | | 3734 |
| HA7-2502/883 | | | 3734 |
| HA2-2510/883 | | /12205BGA | 3697 |
| HA7-2510/883 | | /12205BPA | 3697 |
| HA2-2512/883 | | | 3697 |
| HA4-2512/883 | | | 3697 |
| HA7-2512/883 | | | 3697 |
| HA2-2520/883 | 5962-8988001GC | /12206BGA | 3735 |
| HA7-2520/883 | 5962-8988001PA | /12206BPA | 3735 |
| HA2-2522/883 | 5962-8988001GC | | 3735 |
| HA4-2522/883 | 5962-89880012A | | 3735 |
| HA7-2522/883 | 5962-8988001PA | | 3735 |
| HA2-2529/883 | 5962-8972101GC | | 3736 |
| HA4-2529/883 | 5962-89721012A | | 3736 |
| HA7-2529/883 | 5962-8972101PA | | 3736 |
| HA1-2539/883 | 5962-8778701CA | | 3927 |
| HA4-2539/883 | 5962-87787012A | | 3927 |
| HA1-2540/883 | 5962-8964801CA | | 3929 |
| HA4-2540/883 | 5962-89648012A | | 3929 |
| HA1-2541/883 | 5962-8778501CA | | 2898 |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HA2-2541/883 | 5962-8778501XC | | 3698 |
| HA2-2542/883 | 5962-8964301XC | | 3928 |
| HA2-2544/883 | 5962-8950201GC | | 3699 |
| HA4-2544/883 | 5962-89502012A | | 3699 |
| HA7-2544/883 | 5962-8950201PA | | 3699 |
| HA1-2546/883 | 5962-9325101MEA | | 2444 |
| HA4-2546/883 | 5962-9325101M2A | | 2444 |
| HA2-2548/883 | | | 2472 |
| HA7-2548/883 | | | 2472 |
| HA1-2556/883 | Pending | | 3619 |
| HA1-2557/883 | Pending | | 3638 |
| HA2-2600/883 | | /12202BGA | 3700 |
| HA7-2600/883 | | /12202BPA | 3700 |
| HA2-2602/883 | | | 3700 |
| HA7-2602/883 | | | 3700 |
| HA2-2620/883 | | /12203BGA | 3701 |
| HA7-2620/883 | | /12203BPA | 3701 |
| HA2-2622/883 | | | 3701 |
| HA7-2622/883 | | | 3701 |
| HA2-2640/883 | 7800302GC | | 3702 |
| HA4-2640/883 | 78003022A | | 3702 |
| HA7-2640/883 | 7800302PA | | 3702 |
| HA1-2839/883 | | | 3593 |
| HA1-2840/883 | | | 3594 |
| HA7-2840/883 | 5962-9467901MPA | | 3594 |
| HA1-2841/883 | 5962-8778503CA | | 3621 |
| HA7-2841/883 | 5962-8778503PA | | 3621 |
| HA1-2842/883 | | | 3622 |
| HA7-2842/883 | 5962-94694MPA | | 3622 |
| HA1-2850/883 | | | 3595 |
| HA7-2850/883 | | | 3595 |
| HA1-4741/883 | | | 3704 |
| HA4-4741/883 | | | 3704 |
| HA1-4902/883 | 5962-8686001EA | | 3929 |
| HA4-4902/883 | 5962-86860012A | | 3929 |
| HA2-5002/883 | 5962-8963601GC | | 3705 |
| HA4-5002/883 | 5962-89636012A | | 3705 |
| HA7-5002/883 | 5962-8963601PA | | 3705 |
| HA1-5004/883 | | | 3706 |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HA4-5020/883 | 5962-89620012A | | 3541 |
| HA7-5020/883 | 5962-8962001PA | | 3541 |
| HA5022MJ/883 | | | 3729 |
| HA5023MJ/883 | | | 3730 |
| HA2-5033/883 | 5962-8963301XC | | 3930 |
| HA2-5101/883 | | | 3931 |
| HA4-5101/883 | 5962-89635012A | | 3931 |
| HA7-5101/883 | 5962-8963501PA | | 3931 |
| HA2-5102/883 | 5962-8954801GC | | 3709 |
| HA4-5102/883 | 5962-89548012A | | 3709 |
| HA7-5102/883 | 5962-8954801PA | | 3709 |
| HA1-5104/883 | 5962-8850201CA | | 3710 |
| HA4-5104/883 | 5962-88502012A | | 3710 |
| HA2-5111/883 | 5962-8963101GC | | 3932 |
| HA4-5111/883 | 5962-89631012A | | 3932 |
| HA7-5111/883 | 5962-8963101PA | | 3932 |
| HA2-5112/883 | 5962-8963201GC | | 3711 |
| HA4-5112/883 | 5962-89632012A | | 3711 |
| HA7-5112/883 | 5962-8963201PA | | 3711 |
| HA1-5114/883 | 5962-8963401CA | | 3712 |
| HA4-5114/883 | 5962-89634012A | | 3712 |
| HA2-5127/883 | 5962-8962701GC | | 3751 |
| HA4-5127/883 | 5962-89627012A | | 3751 |
| HA7-5127/883 | 5962-8962701PA | | 3751 |
| HA1-5134/883 | 5962-9455301MCA | | 3713 |
| HA4-5134/883 | 5962-9455301M2A | | 3713 |
| HA2-5135/883 | | | 3731 |
| HA4-5135/883 | | | 3731 |
| HA7-5135/883 | | | 3731 |
| HA2-5137/883 | 5962-8962702GC | | 3714 |
| HA4-5137/883 | 5962-89627022A | | 3714 |
| HA7-5137/883 | 5962-8962702PA | | 3714 |
| HA2-5142/883 | 5962-8965602GC | | 3732 |
| HA4-5142/883 | 5962-89656022A | | 3732 |
| HA7-5142/883 | 5962-8965602PA | | 3732 |
| HA1-5144/883 | 5962-8965603CA | | 3934 |
| HA4-5144/883 | 5962-89656032A | | 3934 |
| HA2-5147/883 | 5962-8962703GC | | 3715 |
| HA4-5147/883 | 5962-89627032A | | 3715 |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HA7-5147/883 | 5962-8962703PA | | 3715 |
| HA2-5177/883 | | | 3733 |
| HA4-5177/883 | | | 3733 |
| HA7-5177/883 | | | 3733 |
| HA1-5190/883 | 5962-8778401CA | | - |
| HA2-5190/883 | 5962-8778401XC | | - |
| HA4-5190/883 | 5962-87784012A | | - |
| HA2-5221/883 | | | 3716 |
| HA4-5221/883 | 5962-9163401M2A | | 3716 |
| HA7-5221/883 | 5962-9163401MPA | | 3716 |
| HA4-5222/883 | 5962-9163402M2A | | 3717 |
| HA7-5222/883 | 5962-9163402MPA | | 3717 |
| HA1-5320/883 | 5962-9306302MCA | | 2927 |
| HA4-5320/883 | 5962-9306302M2A | | 2927 |
| HA1-5330/883 | 5962-8767701CA | | 3935 |
| HA4-5330/883 | 5962-87677012A | | 3935 |
| HA1-5340/883 | 5962-9306301MCA | | 2452 |
| HA4-5340/883 | 5962-9306301M2A | | 2452 |
| HA5351MJ/883 | | | - |
| HA5352MJ/883 | | | - |
| HFA1100MJ/883 | 5962-9467601MPA | | 3615 |
| HFA1110MJ/883 | 5962-9468301MPA | | 3620 |
| HFA1112MJ/883 | | | 3610 |
| HFA1113MJ/883 | 5962-9468201MPA | | 3618 |
| HFA1113ML/883 | 5962-9468201M2A | | 3618 |
| HFA1115MJ/883 | | | 3724 |
| HFA1120MJ/883 | 5962-9468501MPA | | 3617 |
| HFA1130MJ/883 | 5962-9467701MPA | | 3625 |
| HFA1130ML/883 | 5962-9467701M2A | | 3625 |
| HFA1135MJ/883 | | | 3725 |
| HFA1135ML/883 | | | 3725 |
| HFA1145MJ/883 | | | 3726 |
| HFA1212MJ/883 | | | 3742 |
| HFA1245MJ/883 | | | 3743 |
| HFA1412MJ/883 | | | 3744 |
| HI1-0200/883 | | | - |
| HI4-0200/883 | | | - |
| HI1-0201/883 | 7705302EA | | - |
| HI4-0201/883 | 77053022A | | - |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HI1-0201HS/883 | 5962-8671601EA | | - |
| HI4-0201HS/883 | 5962-86716012A | | - |
| HI1-0222/883 | 5962-9456201MXA | | - |
| HI4-0222/883 | 5962-9456201M2A | | - |
| HI2-0300/883 | | | - |
| HI1-0301/883 | | | - |
| HI1-0302/883 | | | - |
| HI1-0306/883 | | | - |
| HI1-0307/883 | | | - |
| HI1-0384/883 | | | - |
| HI1-0390/883 | | | - |
| HI1-0506/883 | 5962-8513107XA | /19001BXA | - |
| HI4-0506/883 | 5962-85131073A | | - |
| HI1-0507/883 | 5962-8513108XA | /19003BXA | - |
| HI4-0507/883 | 5962-85131083A | | - |
| HI1-0508/883 | 7705201EC | /19007BEA | - |
| HI4-0508/883 | 77052012A | | - |
| HI1-0509/883 | 5962-8513109EA | /19008BEA | - |
| HI4-0509/883 | 5962-85131092A | | - |
| HI1-0516/883 | 5962-8869901XA | | 3146 |
| HI4-0516/883 | 5962-88699013A | | 3146 |
| HI1-0518/883 | | | - |
| HI4-0518/883 | | | - |
| HI1-0524/883 | 5962-8761801VA | | 3148 |
| HI1-0546/883 | 5962-8513101XA | /19002BXA | - |
| HI4-0546/883 | 5962-85131013A | | - |
| HI1-0547/883 | 5962-8513102XA | /19004BXA | - |
| HI4-0547/883 | 5962-85131023A | | - |
| HI1-0548/883 | 7705202EA | /19005BEA | - |
| HI4-0548/883 | 77052022A | | - |
| HI1-0549/883 | 5962-8513103EA | /19006BEA | - |
| HI4-0549/883 | 5962-85131032A | | - |
| HI1-565ASD/883 | | | - |
| HI1-565ATD/883 | | | - |
| HI1-574ASD/883 | | | - |
| HI1-574ATD/883 | 5962-8512704XA | | - |
| HI1-574AUD/883 | 5962-8512703XA | | - |
| HI4-574ASE/883 | | | - |
| HI4-574ATE/883 | 5962-8512704YA | | - |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

## Harris Analog/DSP Military Part Number Listing (Continued)

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HI4-574AUE/883 | 5962-8512703YA | | - |
| HI1-674ASD/883 | | | - |
| HI1-674ATD/883 | | | - |
| HI1-674AUD/883 | | | - |
| HI4-674ASE/883 | | | - |
| HI4-674ATE/883 | | | - |
| HI4-674AUE/883 | | | - |
| HI1-774S/883 | | | - |
| HI1-774T/883 | | | - |
| HI1-774U/883 | | | - |
| HI4-774S/883 | | | - |
| HI4-774T/883 | | | - |
| HI4-774U/883 | | | - |
| HI1-1818A/883 | | | - |
| HI1-1828A/883 | | | - |
| HI1-5040/883 | 8100609EA | | - |
| HI1-5041/883 | 8100610EA | | - |
| HI1-5042/883 | 8100611EA | | - |
| HI1-5043/883 | 8100612EA | | - |
| HI4-5043/883 | 81006122A | | - |
| HI1-5044/883 | 8100613EA | | - |
| HI1-5045/883 | 8100614EA | | - |
| HI4-5045/883 | 81006142A | | - |
| HI1-5046/883 | 8100615EA | | - |
| HI1-5046A/883 | 8100617EA | | - |
| HI1-5047/883 | 8100616EA | | - |
| HI1-5047A/883 | 8100618EA | | - |
| HI1-5048/883 | 8100619EA | | - |
| HI1-5049/883 | 8100620EA | | - |
| HI4-5049/883 | 81006202A | | 3127 |
| HI1-5050/883 | 8100621EA | | - |
| HI1-5051/883 | 8100622EA | | - |
| HI4-5051/883 | 81006222A | | - |
| HI1-5700S/883 | 5962-9467801MXA | | - |
| HI1-5701T/883 | | | 3378 |
| HI1-7153S/883 | | | - |
| HSP43168GM-25/883 | | | 3177 |
| HSP43168GM-33/883 | | | 3177 |
| HSP43220GM-15/883 | | | 2802 |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

| MIL-STD-883 PART NO. | DESC/SMD PART NO. | JAN JM38510 PART NO. | HARRIS DATASHEET AnswerFAX NO. (NOTE 3) |
|---|---|---|---|
| HSP43220GM-25/883 | | | 2802 |
| HSP43481GM-20/883 | | | 2450 |
| HSP43481GM-25/883 | | | 2450 |
| HSP43881GM-20/883 | | | 2449 |
| HSP43881GM-25/883 | | | 2449 |
| HSP43891GM-20/883 | 5962-9209701MXC | | 2451 |
| HSP43891GM-25/883 | 5962-9209702MXC | | 2451 |
| HSP45106GM-25/883 | | | 2815 |
| HSP45116GM-15/883 | | | 2813 |
| HSP45116GM-25/883 | | | 2813 |
| HSP45240GM-25/883 | | | 2816 |
| HSP45240GM-33/883 | | | 2816 |
| HSP45240GM-40/883 | | | 2816 |
| HSP45256GM-20/883 | | | 2997 |
| HSP45256GM-25/883 | | | 2997 |
| HSP48410GM-25/883 | 5962-9457301MXC | | 3542 |
| HSP48410GM-33/883 | 5962-9457302MXC | | 3542 |
| HSP48908GM-20/883 | 5962-9300701MXC | | 2783 |
| HSP48908GM-27/883 | 5962-9300702MXC | | 2783 |
| ICL7109MDL/883B | | | - |
| ICL8038AMJD/883B | 5962-8877201CA | | - |
| ICL8038BMJD/883B | | | - |
| ICL8069CMSQ/883B | | | - |
| ICL8069DMSQ/883B | | | - |
| ICM7555MTV/883B | 5962-8950303GC | | - |
| ICM7556MJD/883B | 5962-8950304CA | | - |
| IH5012MDE/883B | | | - |
| IH5043MJE/883B | | | - |
| IH5140MJE/883B | 8100609EA | | - |
| IH5141MJE/883B | 8100610EA | | - |
| IH5142MJE/883B | 8100611EA | | - |
| IH5143MJE/883B | 8100612EA | | - |
| IH5144MJE/883B | 8100613EA | | - |
| IH5145MJE/883B | 8100614EA | | - |
| IH5151MJE/883B | 8100622EA | | - |
| IH5341MTW/883B | | | - |
| IH5352MJE/883B | 5962-8875001EA | | - |
| IH6108MJE/883B | 7705201EA | | - |
| IH6201MJE/883B | | | - |
| IH6208MJE/883B | | | - |

NOTE:

1. In sequence by 2-character prefix (e.g. HA) then base p/n (e.g. 2400) of MIL-STD-883 part number.
2. DESC/SMD part may have different /better electricals than the MIL-STD-883 part number listed.
3. See Section 13 on "How to Use AnswerFAX".

# ANALOG 3

## OPERATIONAL AMPLIFIERS

# Operational Amplifiers (Continued)

HARRIS SEMICONDUCTOR

# HA-2444/883

## Selectable, Four Channel Video Operational Amplifier

July 1994



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Digital Selection of Input Channel**
- **Unity Gain Stable**
- **Gain Flatness (to 10MHz) ........ 0.12dB (Typ)**
- **Differential Gain ................. 0.03% (Typ)**
- **Differential Phase.......... 0.03 Degrees (Typ)**
- **Fast Channel Selection ........... 100ns (Max)**
- **Crosstalk Rejection ............... 60dB (Typ)**

### Applications

- **Programmable Gain Amplifier**
- **Special Effects Processors**
- **Video Distribution Systems/Multiplexers**
- **Heads-up/Night Vision Displays**
- **Radar Video**
- **Flight Simulators**
- **IR Imaging**

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2444/883 | -55°C to +125°C | 16 Lead CerDIP |

### Description

The HA-2444/883 is a channel-selectable video op amp consisting of four differential inputs, a single-ended output, and digital control circuitry allowing two digital inputs to activate one of the four differential inputs. The HA-2444/883 also includes a high impedance output state allowing the outputs of multiple HA-2444/883s to be wire-OR'd. Functionally, the HA-2444/883 is equivalent to four wideband video op amps and a wideband multiplexer.

Unlike similar competitor devices, the HA-2444/883 is not restricted to multiplexing. Any op amp configuration can be used with any of the inputs. Signal amplification, addition, integration, and more can be put under digital control with broadcast quality performance.

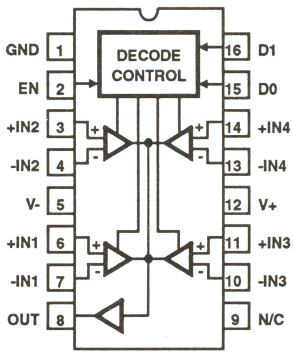
The key video parameters of the HA-2444/883 have been optimized without compromising DC performance. Gain Flatness, to 10MHz, is only 0.12dB. Differential gain and phase are typically 0.03% and 0.03 degrees, respectively.

Laser trimming allows offset voltages in the 4.0mV range and a unique common current source design assures minimal channel-to-channel mismatch, while maintaining 60dB of crosstalk rejection at 5MHz. Open loop gain of 76dB and low input offset and bias currents enhance the performance of this versatile device.

Uses for the HA-2444/883 include video test equipment, guidance systems, radar displays, and other precise imaging systems where stringent gain and phase requirements have previously required costly hybrids and discrete circuitry. It will also be used for systems requiring high speed signal conditioning, such as data acquisition systems, specialized instrumentation, and communications systems.

### Pinout

**HA-2444/883 (CERDIP)**
TOP VIEW




### Logic Operation

**TRUTH TABLE**

| EN | D1 | D0 | SELECTED CHANNEL |
|---|---|---|---|
| H | L | L | 1 |
| H | L | H | 2 |
| H | H | L | 3 |
| H | H | H | 4 |
| L | X | X | NONE-OUT is set to a high impedance state. |

L = Low State (0.8V Max.)
H = High State (2.4V Min.)
X = Don't Care

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511091-883**
File Number **3608.1**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 35V
Differential Input Voltage.................................. 6V
Voltage at Either Input Terminal ...................... V+ to V-
Voltage on Digital Inputs.............. GND +7.5V to GND -0.5V
Peak Output Current (≤10% Duty Cycle) ................. 40mA
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating...................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 82°C/W | 27°C/W |

Package Power Dissipation Limit at +75°C for $T_J \le$ +175°C
CerDIP Package .................................... 1.22W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................... 12.2mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage....................... ±12V to ±15V
$V_{INCM} \le 1/2(V+ - V-)$
$R_L \ge 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤10pF, $V_{OUT}$ = 0V, $V_{IL}$ = 0.8V, $V_{IH}$ = 2.4V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -7 | 7 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Channel to Channel Offset Voltage Mismatch | $V_{IODEV}$ | $V_{CM}$ = 0V | 1 | +25°C | - | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | - | 12 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 250Ω $-R_S$ = 50Ω | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 50Ω $-R_S$ = 250Ω | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 250Ω $-R_S$ = 250Ω | 1 | +25°C | -4 | 4 | µA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µA |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +5V | 4 | +25°C | 71 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 65 | - | dB |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -5V | 4 | +25°C | 71 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 65 | - | dB |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +5V, $V_{OUT}$ = -5V, V+ = 10V, V- = -20V | 1 | +25°C | 68 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 68 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -5V, $V_{OUT}$ = +5V, V+ = 20V, V- = -10V | 1 | +25°C | 68 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 68 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V $R_{LOAD}$ = OPEN | 1 | +25°C | 25 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 25 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = 10V $R_{LOAD}$ = OPEN | 1 | +25°C | - | -25 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -25 | mA |
| Output Current (Device Disabled) | +DISAB | $V_{OUT}$ = 5V, $V_{EN}$ = 0.8V $R_{LOAD}$ = OPEN | 1 | +25°C | - | 860 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 860 | µA |
| | -DISAB | $V_{OUT}$ = -5V, $V_{EN}$ = 0.8V $R_{LOAD}$ = OPEN | 1 | +25°C | - | 860 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 860 | µA |

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤10pF, $V_{OUT}$ = 0V, $V_{IL}$ = 0.8V, $V_{IH}$ = 2.4V, Unless Otherwise Specified. **(Continued)**

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 25 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 25 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -25 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -25 | - | mA |
| Supply Current (Device Disabled) | $+I_{CCDIS}$ | $V_{OUT}$ = 0V, $V_{EN}$ = 0.8V | 1 | +25°C | - | 10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA |
| | $-I_{CCDIS}$ | $V_{OUT}$ = 0V, $V_{EN}$ = 0.8V | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUPPLY}$ = 5V, V+ = 15V, V- = -15V, V+ = 20V, V- = -15V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | -PSRR | $\Delta V_{SUPPLY}$ = 5V, V+ = 15V, V- = -15V, V+ = 15V, V- = -20V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Digital Input Voltages (D0, D1, EN) | $V_{IL}$ | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| | $V_{IH}$ | | 1 | +25°C | 2.4 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.4 | - | V |
| Input Current (D0, D1) | $DX_{IIL}$ | $V_{IL}$ = 0V | 1 | +25°C | - | 1 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 1 | mA |
| | $DX_{IIH}$ | $V_{IH}$ = 5V | 1 | +25°C | - | 1.2 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 1.2 | µA |
| Input Current (EN) | $EN_{IIL}$ | $V_{IL}$ = 0V | 1 | +25°C | - | 50 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 50 | µA |
| | $EN_{IIH}$ | $V_{IH}$ = 5V | 1 | +25°C | - | 1.2 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 1.2 | µA |

### TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤10pF, $A_{VCL}$ = +1V/V, $V_{IL}$ = 0.8V, $V_{IH}$ = 2.4V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 7 | +25°C | 120 | - | V/µs |
| | | | 8 | +125°C, -55°C | 120 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 7 | +25°C | 120 | - | V/µs |
| | | | 8 | +125°C, -55°C | 120 | - | V/µs |
| Channel Select Time | CHSE | Note 1, $V_{EN}$ = 2.4V | 9, 10 | +25°C, +125°C | - | 100 | ns |
| | | | 11 | -55°C | - | 125 | ns |
| Output Enable Time | CHEN | Note 2 | 9 | +25°C | - | 100 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 100 | ns |

NOTES:

1. Measured for all channel combinations. Channel Select time is the delay in switching from channel X to channel Y. Channel Y input set to +5V, all other channels set to 0V. Select time is measured from the 50% point of the critical digital select input to the 50% point on the output.
2. Channel 1 selected with the input at 5V. All other channels set to 0V. Enable input switched from 0.8V to 2.4V. Enable time is measured from the 50% point of the EN input to the 50% point on the output.

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_L$ ≤10pF, $A_{VCL}$ = 1V/V, $V_{IL}$ = 0.8V, $V_{IH}$ = 2.4V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Rise Time | $T_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 11 | ns |
| | | | 1, 4 | -55°C, +125°C | - | 12 | ns |
| Fall Time | $T_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 11 | ns |
| | | | 1, 4 | -55°C, +125°C | - | 12 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 15 | % |
| | | | 1 | -55°C, +125°C | - | 30 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | +25°C | - | 15 | % |
| | | | 1 | -55°C, +125°C | - | 30 | % |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 5V | 1, 2 | +25°C | 3.8 | - | MHz |
| | | | 1, 2 | -55°C, +125°C | 3.8 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | | 1 | +25°C | 1 | - | V/V |
| | | | 1 | -55°C, +125°C | 1 | - | V/V |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | +25°C | - | 750 | mW |
| | | | 1, 3 | -55°C, +125°C | - | 750 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
74mils x 103mils x 19mils ± 1mil
1880µm x 2620µm x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**SUBSTRATE POTENTIAL (Powered Up):** V-

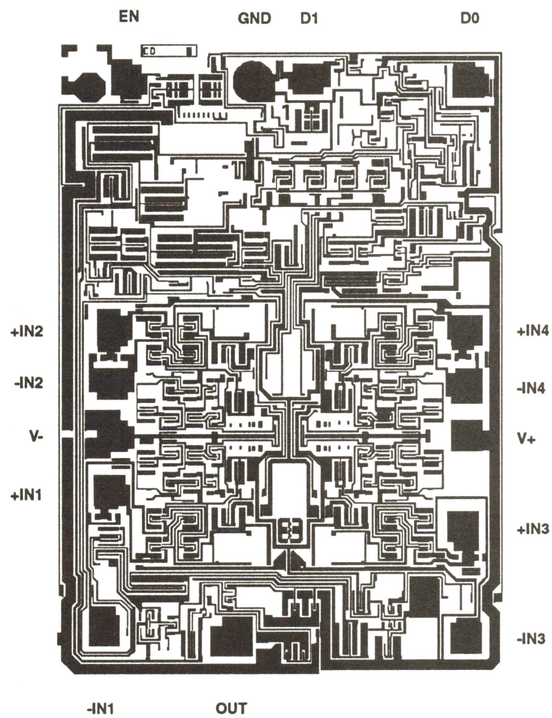
**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**TRANSISTOR COUNT:** 129

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2444/883



# HA-2500/883
# HA-2502/883

HARRIS SEMICONDUCTOR

July 1994

## Precision High Slew Rate Operational Amplifiers

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **High Slew Rate (HA-2500/883) . . . . . . . . . 25V/µs (Min) 30V/µs (Typ)**
- **Wide Power Bandwidth (HA-2500/883). . . 350kHz (Min)**
- **High Input Impedance (HA-2500/883). . . . . 25MΩ (Min) 50MΩ (Typ)**
- **Low Offset Current (HA-2500/883) . . . . . . . 25nA (Max) 10nA (Typ)**
- **Low Quiescent Current . . . . . . . . . . . . . . . . . 6mA (Max)**
- **Fast Settling Time (0.1% of 10V Step) . . . . 330ns (Typ)**
- **High Gain Bandwidth Product . . . . . . . . . 12MHz (Typ)**
- **Internally Compensated For Unity Gain Stability**

### Applications

- **Data Acquisition Systems**
- **RF Amplifiers**
- **Video Amplifiers**
- **Signal Generators**
- **Pulse Amplification**

### Description

HA-2500/883 and HA-2502/883 comprise a series of monolithic operational amplifiers whose designs are optimized to deliver excellent slew rate, bandwidth, and settling time specifications. The outstanding dynamic features of this internally compensated device are complemented with low offset voltage and offset current.

These dielectrically isolated amplifiers are ideally suited for applications such as data acquisition, RF, video, and pulse conditioning circuits. Guaranteed slew rates of ±25V/µs minimum (HA-2500/883) and ±20V/µs minimum (HA-2502/883) make these devices excellent components in fast, accurate data acquisition and pulse amplification designs. To insure compliance, all devices are 100% tested for AC performance characteristics over the full temperature limits.

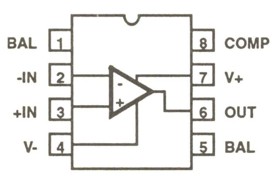
A typical 12MHz gain bandwidth product and 500kHz full power bandwidth make these devices well suited to RF and video applications. With guaranteed offset voltages of 5mV (HA-2500/883) and 8mV (HA-2502/883) plus external offset adjust flexibility and low offset current, these amplifiers are particularly useful components in signal conditioning designs.

### Ordering Information

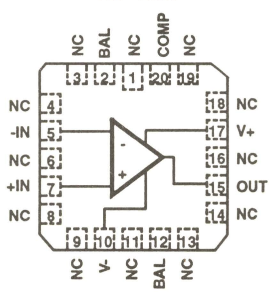
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2500/883 | -55°C to +125°C | 8 Pin Can |
| HA2-2502/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2502/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2500/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA7-2502/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

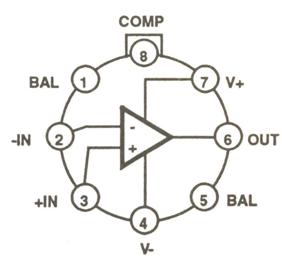
**HA-2500/883, HA-2502/883 (CERDIP)**
TOP VIEW




**HA-2502/883 (CLCC)**
TOP VIEW




**HA-2500/883, HA-2502/883 (METAL CAN)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage .................... 15V
Voltage at Either Input Terminal .................... V+ to V-
Peak Output Current .................... 50mA
Junction Temperature .................... +175°C
Storage Temperature Range .................... -65°C to +150°C
ESD Rating .................... <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |
| Metal Can Package | 160°C/W | 75°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package .................... 870mW
Ceramic LCC Package .................... 1.33W
Metal Can Package .................... 625mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .................... 8.7mW/°C
Ceramic LCC Package .................... 13.3mW/°C
Metal Can Package .................... 6.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range .................... -55°C to +125°C
Operating Supply Voltage .................... ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2500/883 MIN | HA-2500/883 MAX | HA-2502/883 MIN | HA-2502/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -5 | 5 | -8 | 8 | mV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | -10 | 10 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -25 | 25 | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | -100 | 100 | nA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | +10 | - | +10 | - | V |
| | | | 2, 3 | +125°C, -55°C | +10 | - | +10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 20 | - | 15 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 15 | - | 10 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 20 | - | 15 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 15 | - | 10 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -10 | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2500/883 | | HA-2502/883 | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | MIN | MAX | |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 10 | - | 10 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 7.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -10 | - | -10 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -7.5 | - | -7.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 6 | - | 6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6.5 | - | 7 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -6 | - | -6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6.5 | - | -7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2500/883 | | HA-2502/883 | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V 25% ≤ +SR ≤ 75% | 7 | +25°C | 25 | - | 20 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 20 | - | 15 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V 75% ≥ -SR ≥ 25% | 7 | +25°C | 25 | - | 20 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 20 | - | 15 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 60 | - | 60 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 60 | - | 60 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 60 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 60 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | HA-2500/883 | | HA-2502/883 | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 25 | - | 20 | - | MΩ |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 350 | - | 300 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 1 | - | 1 | - | V/V |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 195 | - | 210 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
57 x 65 x 19 mils ± 1 mils
1450 x 1650 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.3 \times 10^5 A/cm^2$

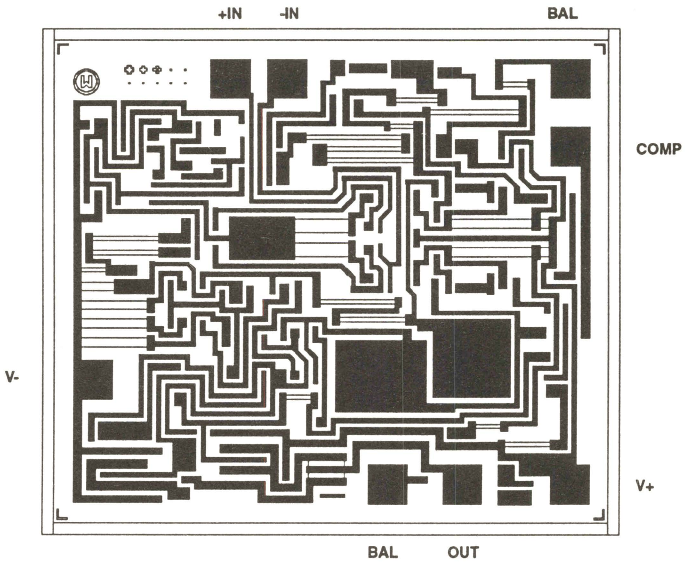
**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

**TRANSISTOR COUNT:**
HA-2500/883: 40
HA-2502/883: 40

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

**HA-2500/883, HA-2502/883**



# HARRIS SEMICONDUCTOR

# HA-2510/883
# HA-2512/883

July 1994

## High Slew Rate Operational Amplifiers

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **High Slew Rate (HA-2510/883) . . . . . . . . . 50V/µs (Min) 65V/µs (Typ)**
- **Wide Power Bandwidth (HA-2510/883). . . 750kHz (Min)**
- **Low Offset Current (HA-2510/883) . . . . . . . . 25nA (Min) 10nA (Typ)**
- **High Input Impedance (HA-2510/883). . . . . 50MΩ (Min) 100MΩ (Typ)**
- **Wide Small Signal Bandwidth. . . . . . . . . . 12MHz (Typ)**
- **Fast Settling Time (0.1% of 10V Step) . . . . 250ns (Typ)**
- **Low Quiescent Supply Current . . . . . . . . . . 6mA (Max)**
- **Internally Compensated For Unity Gain Stability**

### Applications

- **Data Acquisition Systems**
- **RF Amplifiers**
- **Video Amplifiers**
- **Signal Generators**
- **Pulse Amplification**

### Description

The HA-2510/883 and HA-2512/883 are a series of high performance operational amplifiers which set the standards for maximum slew rate and wide bandwidth operation in moderately powered, internally compensated, monolithic devices. In addition to excellent dynamic characteristics, these dielectrically isolated amplifiers also offer low offset current and high input impedance.

The ±50V/µs minimum slew rate and fast settling time of the HA-2510/883 are ideally suited for high speed D/A, A/D, and pulse amplification designs. The HA-2510/883 and the HA-2512/883's superior bandwidth and 750kHz (HA-2510/883) minimum full power bandwidth are extremely useful in RF and video applications. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for AC performance characteristics over full temperature limits. To improve signal conditioning accuracy, the HA-2510/883 provides a maximum offset current of 25nA and a minimum input impedance of 50MΩ, both at +25°C, as well as offset voltage adjust capability.

### Ordering Information

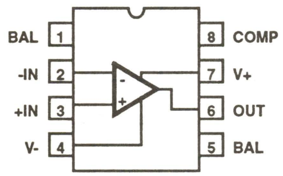
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2510/883 | -55°C to +125°C | 8 Pin Can |
| HA7-2510/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA2-2512/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2512/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2512/883 | -55°C to +125°C | 8 Lead CerDIP |

3

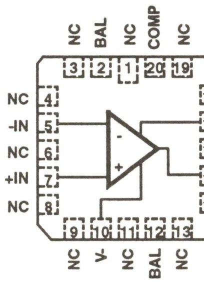
OPERATIONAL AMPLIFIERS

### Pinouts

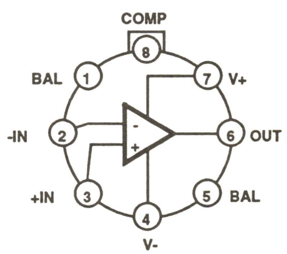
HA-2510/883, HA-2512/883
(CERDIP)
TOP VIEW




HA-2512/883
(CLCC)
TOP VIEW




HA-2510/2512/883
(METAL CAN)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511003-883**
File Number **3697**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage................................ 15V
Voltage at Either Input Terminal ........................ V+ to V-
Peak Output Current ....................................50mA
Junction Temperature.................................. +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating.......................................... <2000V
Lead Temperature (Soldering 10s)..................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |
| Metal Can Package | 160°C/W | 75°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................. 870mW
Ceramic LCC Package ............................ 1.33W
Metal Can Package .............................. 625mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ................................ 8.7mW/°C
Ceramic LCC Package ......................... 13.3mW/°C
Metal Can Package ............................. 6.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage.............................. ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2510/883 MIN | HA-2510/883 MAX | HA-2512/883 MIN | HA-2512/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -8 | 8 | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -18 | 10 | -14 | 14 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -25 | 25 | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | -100 | 100 | nA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | +10 | - | +10 | - | V |
| | | | 2, 3 | +125°C, -55°C | +10 | - | +10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 7.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 7.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -10 | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | - | -10 | V |

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2510/883 MIN | HA-2510/883 MAX | HA-2512/883 MIN | HA-2512/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 10 | - | 10 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 7.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -10 | - | -10 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -7.5 | - | -7.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 6 | - | 6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6.5 | - | 7 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -6 | - | -6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6.5 | - | -7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2510/883 MIN | HA-2510/883 MAX | HA-2512/883 MIN | HA-2512/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V 25% ≤ +SR ≤ 75% | 7 | +25°C | 50 | - | 40 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 45 | - | 35 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V 75% ≥ -SR ≥ 25% | 7 | +25°C | 50 | - | 40 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 45 | - | 35 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 60 | - | 60 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 60 | - | 60 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 60 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 60 | % |

3

OPERATIONAL AMPLIFIERS

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | HA-2510/883 MIN | HA-2510/883 MAX | HA-2512/883 MIN | HA-2512/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 50 | - | 40 | - | MΩ |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 750 | - | 600 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 1 | - | 1 | - | V/V |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 195 | - | 210 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
65 x 57 x 19 mils ± 1 mils
1650 x 1450 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.3 \times 10^5$ A/cm$^2$

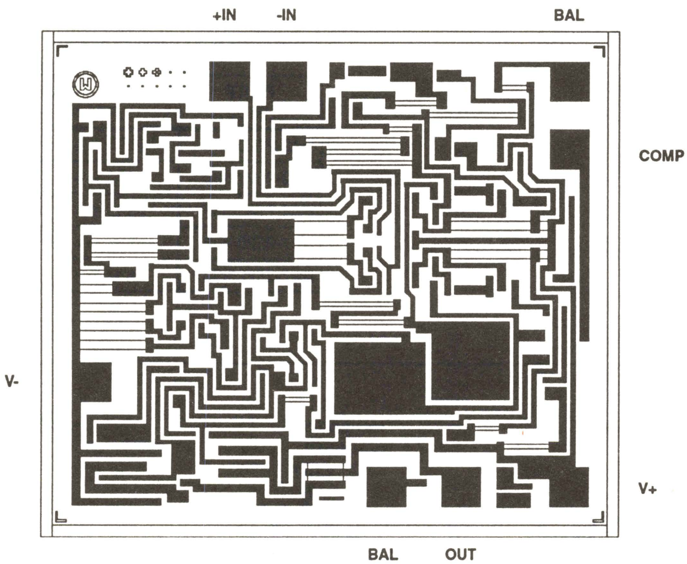
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:**
HA-2510/883: 40
HA-2512/883: 40

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2510/883, HA-2512/883



# HA-2520/883
# HA-2522/883

## Uncompensated, High Slew Rate Operational Amplifiers

July 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **High Slew Rate (HA-2520/883) ........ 100V/µs (Min) 120V/µs (Typ)**
- **Wide Power Bandwidth (HA-2520/883)... 1.5MHz (Min)**
- **Wide Gain Bandwidth (HA-2520/883).... 10MHz (Min) 20MHz (Typ)**
- **High Input Impedance (HA-2520/883)..... 50MΩ (Min) 100MΩ (Typ)**
- **Low Offset Current (HA-2520/883) ........25nA (Min) 10nA (Typ)**
- **Fast Settling (0.1% of 10V Step)......... 200ns (Typ)**
- **Low Quiescent Supply Current ..........6mA (Max)**

### Applications

- **Data Acquisition Systems**
- **RF Amplifiers**
- **Video Amplifiers**
- **Signal Generators**
- **Pulse Amplification**

### Description

Description The HA-2520/883 and HA-2522/883 are monolithic operational amplifiers which deliver an unsurpassed combination of specifications for slew rate, bandwidth and settling time. These dielectrically isolated amplifiers are designed for closed loop gains of 3 or greater without external compensation. In addition, these high performance components also provide low offset current and high input impedance.

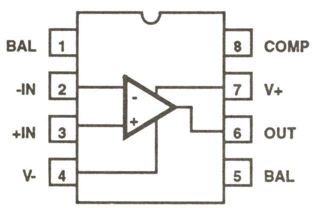
The 100V/µs (min) slew rate (80V/µs for HA-2522/883) and fast settling time of these amplifiers make them ideal components for pulse amplification and data acquisition designs. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for AC performance characteristics over full temperature. These devices are valuable components for RF and video circuitry requiring wideband operation. For accurate signal conditioning designs, the HA-2520/883's superior dynamic specifications are complemented by 25nA (max) offset current (50nA for HA-2522/883) and offset voltage adjust capability.

### Ordering Information

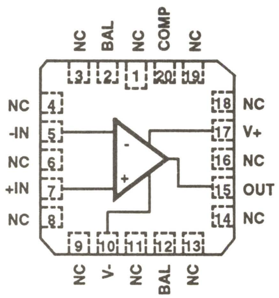
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2520/883 | -55°C to +125°C | 8 Pin Can |
| HA2-2522/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2522/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2520/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA7-2522/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

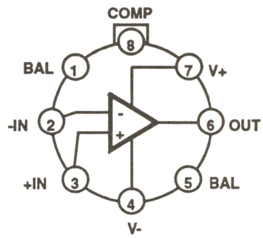
**HA-2520/883, HA-2522/883**
**(CERDIP)**
TOP VIEW




**HA-2522/883**
**(CLCC)**
TOP VIEW




**HA-2520/883, HA-2522/883**
**(METAL CAN)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511004-883**
File Number **3735**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage .................... 15V
Voltage at Either Input Terminal .................... V+ to V-
Peak Output Current .................... 50mA
Junction Temperature .................... +175°C
Storage Temperature Range .................... -65°C to +150°C
ESD Rating .................... <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |
| Metal Can Package | 160°C/W | 75°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package .................... 870mW
Ceramic LCC Package .................... 1.33W
Metal Can Package .................... 625mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .................... 8.7mW/°C
Ceramic LCC Package .................... 13.3mW/°C
Metal Can Package .................... 6.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range .................... -55°C to +125°C
Operating Supply Voltage .................... ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq$ 2kΩ

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2520/883 MIN | HA-2520/883 MAX | HA-2522/883 MIN | HA-2522/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -8 | 8 | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | -14 | 14 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -200 | 200 | -250 | 250 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | -500 | 500 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -25 | 25 | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | -100 | 100 | nA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | +10 | - | +10 | - | V |
| | | | 2, 3 | +125°C, -55°C | +10 | - | +10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 7.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 7.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -10 | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2520/883 MIN | HA-2520/883 MAX | HA-2522/883 MIN | HA-2522/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 10 | - | 10 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | 7.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -10 | - | -10 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -7.5 | - | -7.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 6 | - | 6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6.5 | - | 7 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -6 | - | -6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6.5 | - | -7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +3V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2520/883 MIN | HA-2520/883 MAX | HA-2522/883 MIN | HA-2522/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT} = -5V$ to $+5V$, $25\% \le +SR \le 75\%$ | 7 | +25°C | 100 | - | 80 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 84 | - | 60 | - | V/µs |
| | -SR | $V_{OUT} = +5V$ to $-5V$, $75\% \ge -SR \ge 25\%$ | 7 | +25°C | 100 | - | 80 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 84 | - | 60 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT} = 0$ to $+200mV$, $10\% \le T_R \le 90\%$ | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 55 | - | 60 | ns |
| | $T_F$ | $V_{OUT} = 0$ to $-200mV$, $10\% \le T_F \le 90\%$ | 7 | +25°C | - | 50 | - | 50 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 55 | - | 60 | ns |
| Overshoot | +OS | $V_{OUT} = 0$ to $+200mV$ | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 45 | - | 60 | % |
| | -OS | $V_{OUT} = 0$ to $-200mV$ | 7 | +25°C | - | 40 | - | 50 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 45 | - | 60 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V \geq 3$, $C_{COMP} = 0pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | HA-2520/883 | | HA-2522/883 | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 50 | - | 40 | - | MΩ |
| Full Power Bandwidth | GBWP | $V_O = 200mV$, $f_O = 10kHz$ | 1 | +25°C | 10 | - | 10 | - | MHz |
| | | $V_O = 200mV$, $f_O = 1MHz$ | 1 | +25°C | 10 | - | 10 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 1.6 | - | 1.2 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | +3 | - | +3 | - | V/V |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 195 | - | 210 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
67 x 57 x 19 mils ± 1 mils
1700 x 1440 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.26 \times 10^5$ A/cm$^2$

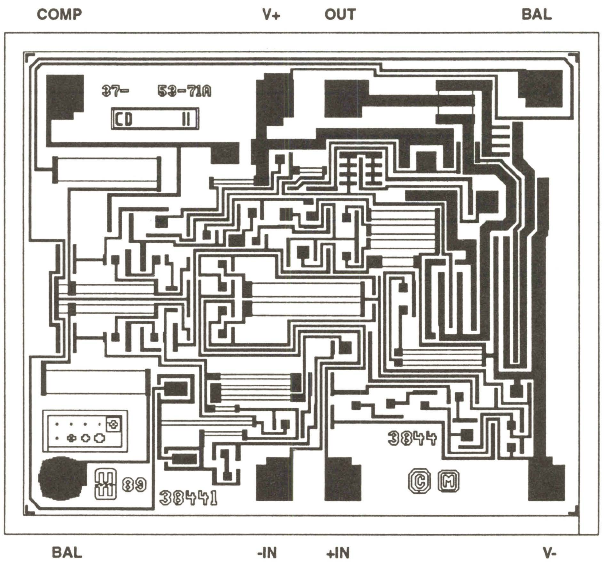
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:**
HA-2520/883: 40
HA-2522/883: 40

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2520/883, HA-2522/883



HARRIS SEMICONDUCTOR

# HA-2529/883

## Uncompensated, High Slew Rate High Output Current, Operational Amplifier

July 1994

3 OPERATIONAL AMPLIFIERS

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate .................... 135V/µs (Min) 150V/µs (Typ)
- High Output Current ................ ±30mA (Min)
- High Gain-Bandwidth Product ....... 15MHz (Min) 20MHz(Typ)
- Wide Power Bandwidth ............. 2.1MHz (Min)
- High Input Impedance ............... 50MΩ (Min) 130MΩ (Typ)
- Low Offset Current ................. 25nA (Max) 5nA (Typ)
- Fast Settling (10V Step to 0.1%) ......... 200ns (Typ)
- Low Quiescent Supply Current ....... 6mA (Max)

### Applications

- Data Acquisition Systems
- RF Amplifiers
- Video Amplifiers
- Signal Generators
- Pulse Amplification

### Description

The HA-2529/883 is a monolithic operational amplifier which typifies excellence of design. With a design based on years of experience coupled with the reliable dielectric isolation process, these amplifiers provide an outstanding combination of DC and AC parameters at closed loop gains of 3 or greater without external compensation.

The HA-2529/883 offers 135V/µs (min) slew rate and fast settling time (200ns typ), while consuming a mere 6mA (max) quiescent supply current, making these amplifiers ideal components for video circuitry and data acquisition designs. With 15MHz minimum gain-bandwidth product combined with 7.5kV/V minimum open loop gain, the HA-2529/883 is an ideal component for demanding signal conditioning designs. These devices provide ±30mA (min) output current drive with an output voltage swing of ±10V (min), making then suited for pulse amplifier and RF amplifier components.

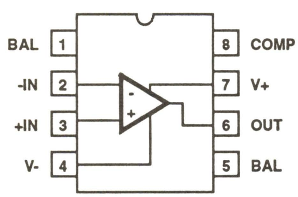
HA-2529/883 will upgrade a system presently using the HA-2520/22/883 or EHA-2520/22/883 in regards to output current, slew rate, offset voltage drift, and offset current drift. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for AC performance characteristics over full temperature.

### Ordering Information

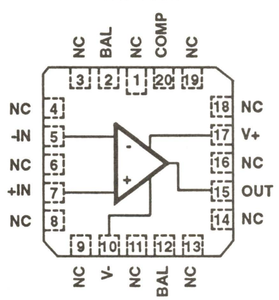
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2529/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2529/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2529/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

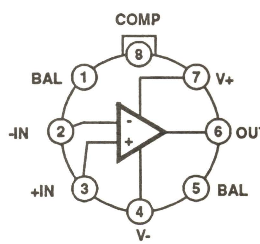
HA-2529/883
(CERDIP)
TOP VIEW




HA-2529/883
(CLCC)
TOP VIEW




HA-2529/883
(METAL CAN)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage ................................ 15V
Voltage at Either Input Terminal ........................ V+ to V-
Peak Output Current ..................................... 50mA
Junction Temperature ................................... +175°C
Storage Temperature Range .................. -65°C to +150°C
ESD Rating ................................................ <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |
| Metal Can Package | 160°C/W | 75°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ............................ 870mW
Ceramic LCC Package ...................... 1.33W
Metal Can Package ......................... 625mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................ 8.7mW/°C
Ceramic LCC Package ...................... 13.3mW/°C
Metal Can Package ......................... 6.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ............................. ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 500\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -5 | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -400 | 400 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | nA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | +10 | - | V |
| | | | 2, 3 | +125°C, -55°C | +10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 7.5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 83 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 83 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 30 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 20 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -30 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -20 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +3V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V 25% ≤ +SR ≤ 75% | 7 | +25°C | 135 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 125 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V 75% ≥ -SR ≥ 25% | 7 | +25°C | 135 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 125 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 7 | +25°C | - | 45 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 7 | +25°C | - | 45 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 40 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $C_{COMP} = 0pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 50 | - | MΩ |
| Gain Power Bandwidth | GBWP | $V_O = 200mV$, $f_O \geq 10kHz$ | 1 | +25°C | 15 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 2.1 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | ±3 | - | V/V |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 60 | Ω |
| Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 210 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
67 x 57 x 19 ± 1 mils
1700 x 1440 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.78 \times 10^5$ A/cm$^2$

**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

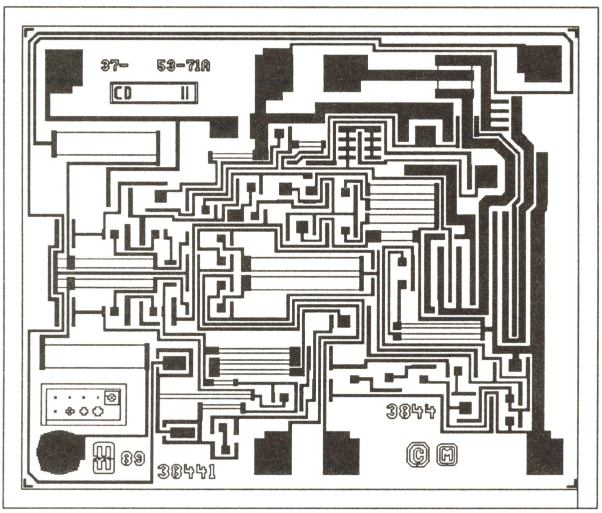
**TRANSISTOR COUNT:** 40

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2529/883

COMP V+ OUT BAL




BAL -IN +IN V-

![HARRIS SEMICONDUCTOR]

# HA-2541/883

July 1994

## Wideband, Fast Settling, Unity Gain Stable, Operational Amplifier

### Features

- **This Circuit Is Processed In Accordance to MIL-STD-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Unity Gain Bandwidth ................ 40MHz (Min)**
- **High Slew Rate ..................... 200V/μs (Min)**
  **250V/μs (Typ)**
- **Low Offset Voltage .................... 2mV (Max)**
- **Fast Settling Time (0.1%) ............... 90ns (Typ)**
- **Power Bandwidth .................... 3MHz (Min)**
  **4MHz (Typ)**
- **Output Voltage Swing .................. ±10V (Min)**
- **Unity Gain Stability**
- **Monolithic Bipolar Dielectric Isolation Construction**

### Applications

- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **High Speed Sample and Hold Circuits**
- **Fast, Precise D/A Converters**
- **High Speed A/D Input Buffer**

### Description

The HA-2541/883 is the first unity gain stable monolithic operational amplifier to achieve 40MHz unity gain bandwidth. A major addition to the Harris series of high speed, wideband op amps, the HA-2541/883 is designed for video and pulse applications requiring stable amplifier response at low closed loop gains.

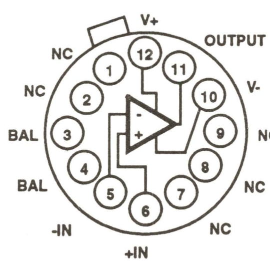
The uniqueness of the HA-2541/883 is that its slew rate and bandwidth characteristics are specified at unity gain. Historically, high slew rate, wide bandwidth and unity gain stability have been incompatible features for a monolithic operational amplifier. But features such as 250V/μs slew rate and 40MHz unity gain bandwidth clearly show that this is not the case for the HA-2541/883. These features, along with 90ns settling time to 0.1%, make this product an excellent choice for high speed data acquisition systems.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2541/883 | -55°C to +125°C | 12 Pin Can |

### Pinout

**HA-2541/883**
**(METAL CAN)**
TOP VIEW




**CASE TIED TO V-**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 35V
Differential Input Voltage .............................. 6V
Voltage at Either Input Terminal ..................... V+ to V-
Peak Output Current (< 10% Duty Cycle) ................ 50mA
Junction Temperature ($T_J$) ........................ +175°C
Storage Temperature Range .................. -65°C to +150°C
ESD Rating ........................................ <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

Thermal Resistance — $\theta_{JA}$ / $\theta_{JC}$
Metal Can Package ................. 65°C/W 34°C/W
Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
Metal Can Package ................................ 1.54W
Package Power Dissipation Derating Factor Above +75°C
Metal Can Package ........................... 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ........................ ±12V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ, $-R_S$ = 100Ω | 1 | +25°C | -35 | 35 | µA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 1.1kΩ | 1 | +25°C | -35 | 35 | µA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ, $-R_S$ = 1.1kΩ | 1 | +25°C | -7 | 7 | µA |
| | | | 2, 3 | +125°C, -55°C | -9 | 9 | µA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 1kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 1kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |

3 OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 1 | +25°C | 10 | - | mA |
| | | | 1, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 1 | +25°C | - | -10 | mA |
| | | | 1, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 39 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 39 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -39 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -39 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +5V, V- = -15V, V+ = +15V, V- = -15V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -5V, V+ = +15V, V- = -15V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 10pF, $A_V$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 40 | - | kΩ |
| Unity Gain Bandwidth | UGBW | $V_O$ = 90mV | 1 | +25°C | 40 | - | MHz |
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 1 | +25°C | 200 | - | V/μs |
| | -SR | $V_{OUT}$ = +3V to -3V | 1 | +25°C | 200 | - | V/μs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 3 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 1kΩ, $C_L$ = 10pF | 1 | -55°C to +125°C | 1 | - | V/V |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 20 | ns |
| | $T_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 20 | ns |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 10pF$, $A_V = 1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 50 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | +25°C | - | 50 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 25 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 1.17 | W |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
80 x 90 x 19 mils ± 1 mils
2020 x 2280 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride(Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$5.3 \times 10^4$ A/cm$^2$

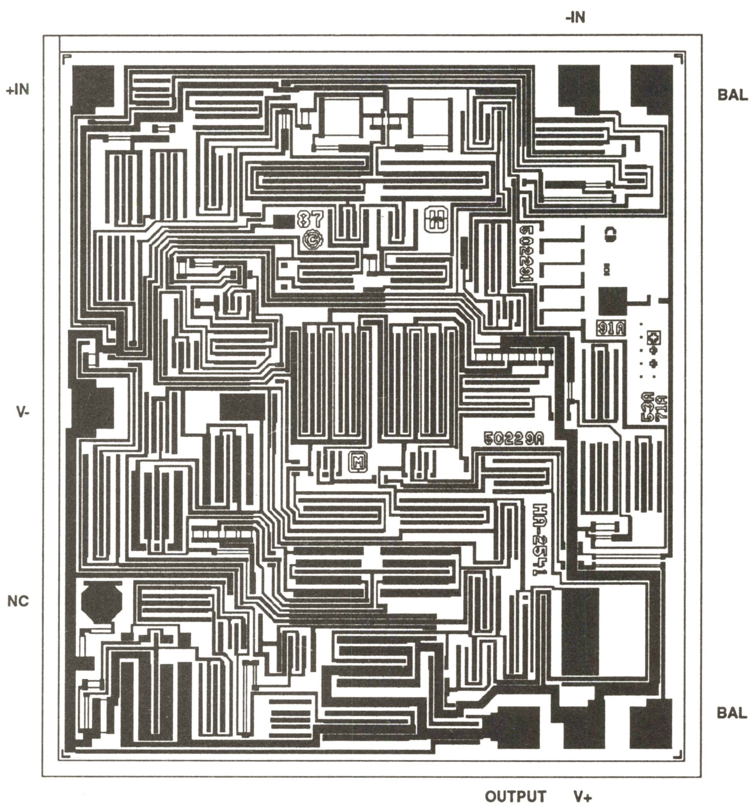
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 41

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2541/883



# HA-2544/883

July 1994

## Video Operational Amplifier



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Wide Unity Gain Bandwidth ........... 45MHz (Min)**
- **High Slew Rate...................... 100V/μs (Min)**
- **Low Supply Current................... 12mA (Max)**
- **Differential Gain Error................ 0.04dB (Max)**
- **Differential Phase Error............. 0.11 Deg. (Max)**
- **Gain Flatness at 3.58MHz or 4.43MHz ... 0.15dB (Max)**
- **Fast Settling Time (10V to 0.1%)......... 120ns (Typ)**

### Applications

- **Video Systems**
- **Video Test Equipment**
- **Radar Displays**
- **Imaging Systems**
- **Pulse Amplifiers**
- **Signal Conditioning Circuits**
- **Data Acquisition Systems**

### Description

The HA-2544/883 is a fast, unity gain stable, monolithic op amp designed to meet the needs required for accurate reproduction of video or high speed signals. It offers high voltage gain (3.5kV/V min, 6kV/V typ), wide unity gain bandwidth of 45MHz minimum and phase margin of 65 degrees (open loop). Built from high quality Dielectric Isolation, the HA-2544/883 is another addition to the Harris series of high speed, wideband op amps, and offers true video performance combined with the versatility of an op amp.

The primary features of the HA-2544/883, include wide bandwidth, 150V/μs (typ) slew rate, < 0.04dB differential gain error, < 0.11 degrees differential phase error and gain flatness of just 0.15dB at 3.58MHz and 4.43MHz, therefore proving to be sufficient for video amplification. High performance and low power requirements are met with a supply current of only 10mA typically and 12mA over the full temperature range.

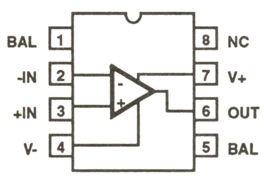
Uses of the HA-2544/883 range from video test equipment guidance systems, radar displays and other precise imaging systems where stringent gain and phase requirements have previously been met with costly hybrids and discrete circuitry. The HA-2544/883 will also be used in non-video systems requiring high speed signal conditioning such as data acquisition systems, medical electronics, specialized instrumentation and communication systems.

### Ordering Information

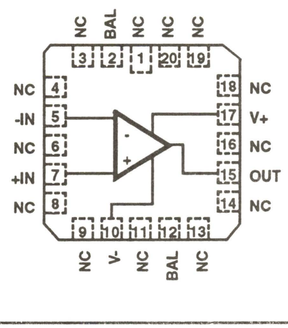
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2544/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2544/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2544/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

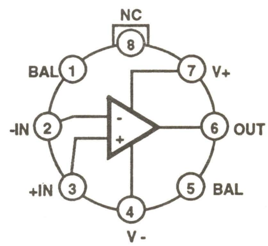
**HA-2544/883 (CERDIP)**
TOP VIEW




**HA-2544/883 (CLCC)**
TOP VIEW




**HA-2544/883 (METAL CAN)**
TOP VIEW




CASE TIED TO V-

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 35V
Differential Input Voltage (Note 2)........................ 6V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current (< 10% Duty Cycle).................40mA
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating......................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Ceramic LCC Package ............................ 1.54W
Metal Can Package ............................. 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .............................8.7mW/°C
Ceramic LCC Package ........................15.4mW/°C
Metal Can Package ...........................6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage.............................. ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 10Ω, $R_{LOAD}$ = 500kΩ, $C_{LOAD} \leq$ 10pF, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1kΩ, $-R_S$ = 10Ω | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10Ω, $-R_S$ = 1kΩ | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1kΩ, $-R_S$ = 1kΩ | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +8V, $R_L$ = 1kΩ | 4 | +25°C | 3.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 2.5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -8V, $R_L$ = 1kΩ | 4 | +25°C | 3.5 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 2.5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 10Ω, $R_{LOAD}$ = 500kΩ, $C_{LOAD}$ ≤ 10pF, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -9V | 1 | +25°C | 25 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +9V | 1 | +25°C | - | -25 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 12 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 12 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -12 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -12 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. To achieve optimum AC performance, the input stage was designed without protective diode clamps. Exceeding the maximum differential input voltage results in reverse breakdown to the base-emitter junction of the input transistors and probable degradation of the input parameters especially $V_{OS}$, $I_{OS}$ and Noise.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 10pF, $V_{OUT}$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 7 | +25°C | 100 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 7 | +25°C | 100 | - | V/µs |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 10pF, $A_V$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Differential Gain | $dA_V$ | $R_S$ = 50Ω, $R_L$ = 1kΩ, $f_O$ = 3.58MHz and 4.43MHz | 1, 5, 6, 8 | +25°C | - | 0.04 | dB |
| Differential Phase | dØ | $R_S$ = 50Ω, $R_L$ = 1kΩ, $f_O$ = 3.58MHz and 4.43MHz | 1, 6, 8 | +25°C | - | 0.11 | Degrees |
| Unity Gain Bandwidth | UGBW | $V_O$ = 200mV$_{RMS}$, f at -3dB | 1 | +25°C | 45 | - | MHz |

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 10pF$, $A_V = 1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Flatness | $\Delta A_V$ | $V_O = 200mV_{RMS}$, $f_O = 5MHz$ | 1, 6 | +25°C | -0.15 | 0.15 | dB |
| | | $V_O = 200mV_{RMS}$, $f_O = 10MHz$ | 1, 6 | +25°C | -0.35 | 0.35 | dB |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 1V$ | 1, 2 | +25°C | 15.9 | - | MHz |
| | | $V_{PEAK} = 5V$ | 1, 2 | +25°C | 3.2 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 1k\Omega$, $C_L \le 1pF$ | 1 | -55°C to +125°C | 1 | - | V/V |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 15 | ns |
| | $T_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 15 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 20 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | +25°C | - | 20 | % |
| Settling Time | $T_S$ | Open Loop | 1 | +25°C | - | 150 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 40 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 360 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.
5. $A_D(\%) = \left[ 10^{\frac{A_D(dB)}{20}} - 1 \right] \times 100$
6. The video parameter specifications will degrade as the output load resistance decreases.
7. C-L Gain and C-L Delay were less than the resolution of the test equipment used which is 0.1dB and 7ns, respectively.
8. Test signal used is $200mV_{RMS}$ at each frequency on a 0 and 1 volt offset. For adequate test repeatability, a minimum warm-up of 2 minutes is suggested.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
80 x 64 x 19 mils ± 1 mils
2030 x 1630 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SIO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$7.0 \times 10^4$ A/cm$^2$

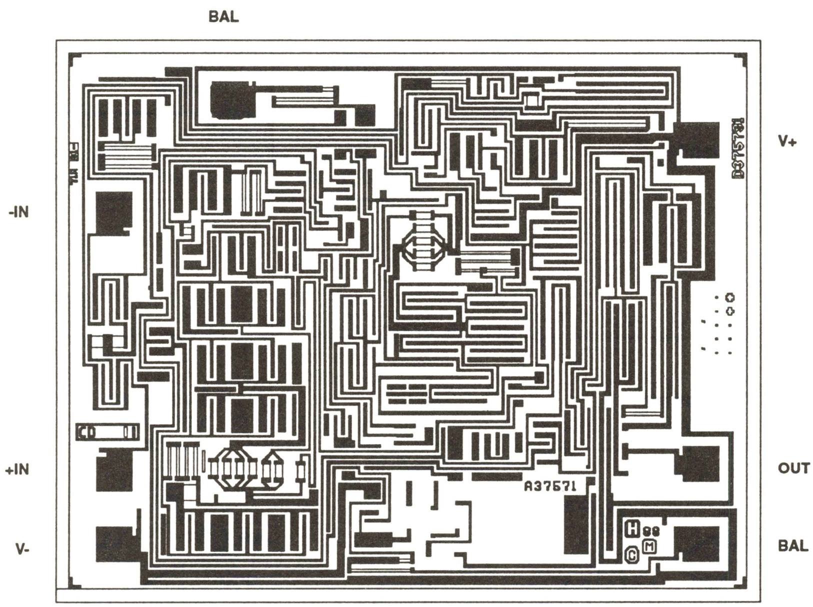
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 44

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2544/883



HARRIS SEMICONDUCTOR

# HA-2548/883

## Precision, High Slew Rate, Wideband Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate .................... 120V/µs (Typ)
- Low Offset Voltage .................... 300µV (Typ) 900µV (Max)
- High Open Loop Gain .................... 130dB (Typ) 114dB (Min)
- Gain Bandwidth Product .................... 150MHz (Typ)
- Low Voltage Noise at 1kHz .................... 8.3nV/√Hz (Typ)
- Minimum Gain Stability .................... ≥ 5 (Typ)

### Applications

- High Speed Instrumentation
- Data Acquisition Systems
- Analog Signal Conditioning
- Precision, Wideband Amplifiers
- Pulse/RF Amplifiers

### Description

The HA-2548/883 is a monolithic op amp that offers a unique combination of bandwidth, slew rate, and precision specifications. These features can eliminate the need for composite op amp designs and external calibration circuitry.

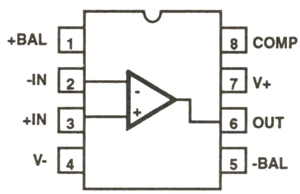
Optimized for gains ≥5, the HA-2548/883 has a gain bandwidth product of 150MHz (typ) and a slew rate of 120V/µs (typ) while maintaining an extremely high open loop gain of 130dB (typ) and a low offset voltage of 300µV (typ). These specifications are achieved through uniquely designed input circuitry and a single ultra-high gain stage that minimizes the AC signal path. Capable of delivering over 30mA (min) of output current, the HA-2548/883 is ideal for precision, high speed applications such as signal conditioning, instrumentation, video/pulse amplifiers and buffers.

### Ordering Information

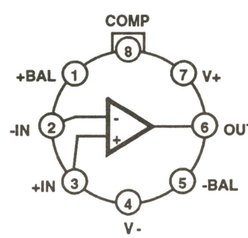
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2548/883 | -55°C to +125°C | 8 Pin Can |
| HA7-2548/883 | -55°C to +125°C | 8 Lead Sidebraze DIP |

### Pinouts

**HA-2548/883**
**(SBDIP)**
TOP VIEW




**HA-2548/883**
**(METAL CAN)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





File Number 511069-883
File Number 2472.1

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage................................ 5V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current (< 10% Duty Cycle).................60mA
Continuous Output Current.............................40mA
Junction Temperature.............................. +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating......................................<2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| Ceramic Sidebraze DIP Package | 97°C/W | 20°C/W |
| Metal Can Package | 142°C/W | 66°C/W |

Package Power Dissipation Limit at +75°C
Ceramic Sidebraze DIP Package .....................1.03W
Metal Can Package .................................0.70W
Package Power Dissipation Derating Factor Above +75°C
Ceramic Sidebraze DIP Package ................10.3mW/°C
Metal Can Package ............................7.0mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage.............................. ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 1k\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -900 | 900 | µV |
| | | | 2, 3 | +125°C, -55°C | -1200 | 1200 | µV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100Ω | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -100 | 100 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100.1kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -100 | 100 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100.1kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -100 | 100 | nA |
| Common Mode Range | +CMR | V+ = +8V, V- = -22V | 1 | +25°C | 7 | - | V |
| | | | 2, 3 | +125°C, -55°C | 7 | - | V |
| | -CMR | V+ = +22V, V- = -8V | 1 | +25°C | - | -7 | V |
| | | | 2, 3 | +125°C, -55°C | - | -7 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 1kΩ | 4 | +25°C | 114 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 108 | - | dB |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 1kΩ | 4 | +25°C | 114 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 108 | - | dB |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +2V, V+ = +13V, V- = -17V, $V_{OUT}$ = -2V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -2V, V+ = +17V, V- = -13V, $V_{OUT}$ = +2V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | 11 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | - | -11 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | 30 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 30 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | - | -30 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 18 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 18 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -18 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -18 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Characteristics in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤ 10pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM}$ = 0V | 1 | -55°C to +125°C | - | 7 | μV/°C |
| Offset Voltage Adjust | $V_{IO}Adj$ | | 1, 5 | +25°C | 1 | - | mV |
| Input Noise Voltage Density | $E_N$ | $R_S$ = 10Ω, $f_O$ = 1kHz | 1 | +25°C | - | 13.0 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 500Ω, $f_O$ = 1kHz | 1 | +25°C | - | 1.0 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_O$ = 1.0V, $f_O$ = 1MHz | 1 | +25°C | - | 130 | MHz |
| | | | 1 | -55°C to +125°C | - | 110 | MHz |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤ 10pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 1 | +25°C | 80 | - | V/µs |
| | | | 1 | -55°C to +125°C | 70 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 1 | +25°C | 80 | - | V/µs |
| | | | 1 | -55°C to +125°C | 70 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 1.11 | - | MHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 1kΩ, $C_L$ = 10pF | 1 | -55°C to +125°C | 5 | - | V/V |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = -100mV to +100mV | 1, 4 | +25°C | - | 15 | ns |
| | | | 1, 4 | -55°C to +125°C | - | 20 | ns |
| | $T_F$ | $V_{OUT}$ = +100mV to -100mV | 1, 4 | +25°C | - | 15 | ns |
| | | | 1, 4 | -55°C to +125°C | - | 20 | ns |
| Overshoot | +OS | $V_{OUT}$ = -100mV to +100mV | 1 | +25°C | - | 30 | % |
| | | | 1 | -55°C to +125°C | - | 35 | % |
| | -OS | $V_{OUT}$ = +100mV to -100mV | 1 | +25°C | - | 30 | % |
| | | | 1 | -55°C to +125°C | - | 35 | % |
| Settling Time | $T_S$ | To 0.01% for a 10V Step | 1 | +25°C | - | 260 | ns |
| Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 540 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.
5. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
85 x 91 x 19 mils ± 1 mils
2160 x 2320 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.6 \times 10^4$ A/cm$^2$

**SUBSTRATE POTENTIAL (Powered Up):** V- (Note)

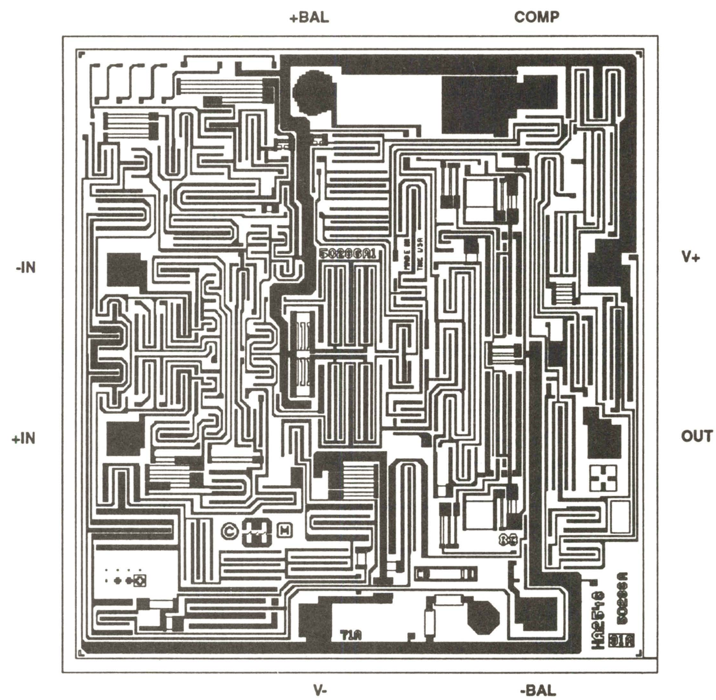
**TRANSISTOR COUNT:** 60

**PROCESS:** Bipolar, Dielectric Isolation

NOTE: The Substrate may be left floating (Insulating Die Mount) or it may be mounted on a conductor at a V- potential.

## Metallization Mask Layout

HA-2548/883



# HA-2600/883
# HA-2602/883

## Wideband, High Impedance Operational Amplifiers

July 1994

### Features

- **This Circuit Is Processed In Accordance to MIL-STD-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **High Input Impedance (HA-2600/883). . . . 100MΩ (Min) 500MΩ (Typ)**
- **High Slew Rate. . . . . . . . . . . . . . . . . . . . . . . 4V/µs (Min) 7V/µs (Typ)**
- **Low Input Bias Current (HA-2600/883). . . . 10nA (Max) 1nA (Typ)**
- **Low Input Offset Current (HA-2600/883) . . . 4mV (Max)**
- **Wide Unity Gain Bandwidth . . . . . . . . . . . 12MHz (Typ)**
- **Output Short Circuit Protection**

### Applications

- **Video Amplifier**
- **Pulse Amplifier**
- **High-Q Active Filters**
- **High Speed Comparators**
- **Low Distortion Oscillators**

### Description

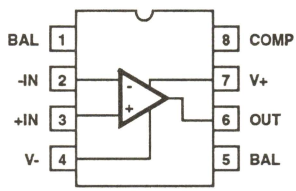
HA-2600/883 and HA-2602/883 are internally compensated bipolar operational amplifiers that feature very high input impedance coupled with wideband AC performance. The high resistance of the input stage is complemented by low offset voltage (4mV max at +25°C for HA-2600/883) and low bias and offset current (10nA max at +25°C for HA-2600/883) to facilitate accurate signal processing. Offset voltage can be reduced further by means of an external nulling potentiometer. The 4V/µs minimum slew rate at +25°C and the minimum open loop gain of 100kV/V at +25°C enables the HA-2600/883 to perform high gain amplification of fast, wideband signals. These dynamic characteristics, coupled with fast settling times, make these amplifiers ideally suited to pulse amplification designs as well as high frequency or video applications. The frequency response of the amplifier can be tailored to exact design requirements by means of an external bandwidth control capacitor. Other high performance designs such as high gain, low distortion audio amplifiers, high-Q and wideband active filters and high speed comparators, are excellent uses of this part.

### Ordering Information

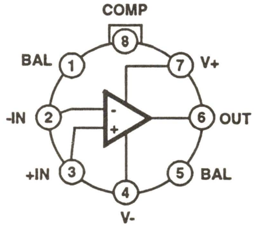
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2600/883 | -55°C to +125°C | 8 Pin Can |
| HA7-2600/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA2-2602/883 | -55°C to +125°C | 8 Pin Can |
| HA7-2602/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

HA-2600/883, HA-2602/883
(CERDIP)
TOP VIEW




HA-2600/883, HA-2602/883
(METAL CAN)
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage ............................... 12V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current .............. Full Short Circuit Protection
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating ........................................ <2000V
Lead Temperature (Soldering 10s) ..................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Metal Can Package | 160°C/W | 75°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Metal Can Package ............................. 625mW
Package Power Dissipation Derating Factor Above +75°C
CersDIP Package ............................. 8.7mW/°C
Metal Can Package ............................ 6.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................. -55°C to +125°C
Operating Supply Voltage ................................ ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq$ 2kΩ

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2600/883 MIN | HA-2600/883 MAX | HA-2602/883 MIN | HA-2602/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -4 | 4 | -5 | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | -7 | 7 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -10 | 10 | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | -60 | 60 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -10 | 10 | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | -60 | 60 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -10 | 10 | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | -60 | 60 | nA |
| Common Mode Range | +CMR | V+ = +4V, V- = -26V | 1 | +25°C | 11 | - | 11 | - | V |
| | | | 2, 3 | +125°C, -55°C | 11 | - | 11 | - | V |
| | -CMR | V+ = +26V, V- = -4V | 1 | +25°C | - | -11 | - | -11 | V |
| | | | 2, 3 | +125°C, -55°C | - | -11 | - | -11 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | 80 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 70 | - | 60 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | 80 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 70 | - | 60 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | 10 | - | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -10 | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2600/883 MIN | HA-2600/883 MAX | HA-2602/883 MIN | HA-2602/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 15 | - | 10 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 10 | - | 7.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -15 | - | -10 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -10 | - | -7.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 3.7 | - | 3.7 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4.0 | - | 4.0 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -3.7 | - | -3.7 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4.0 | - | -4.0 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = \pm5V$, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| | -PSRR | $\Delta V_{SUP} = \pm5V$, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V | 1 | +25°C | 80 | - | 74 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | 74 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | HA-2600/883 MIN | HA-2600/883 MAX | HA-2602/883 MIN | HA-2602/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 7 | +25°C | 4 | - | 4 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 3 | - | 3 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 7 | +25°C | 4 | - | 4 | - | V/µs |
| | | | 8A, 8B | +125°C, -55°C | 3 | - | 3 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV, $10\% \leq T_R \leq 90\%$ | 7 | +25°C | - | 60 | - | 60 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 70 | - | 70 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV, $10\% \leq T_F \leq 90\%$ | 7 | +25°C | - | 60 | - | 60 | ns |
| | | | 8A, 8B | +125°C, -55°C | - | 70 | - | 70 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | - | 40 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 50 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | - | 40 | % |
| | | | 8A, 8B | +125°C, -55°C | - | 50 | - | 50 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | HA-2600/883 MIN | HA-2600/883 MAX | HA-2602/883 MIN | HA-2602/883 MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 100 | - | 40 | - | MΩ |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 50 | - | 50 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 1 | - | 1 | - | V/V |
| Output Short Circuit Current | $+I_{SC}$ | $V_{OUT} = 1V$, $R_L = 10\Omega$ | 1 | +25°C | - | 50 | - | 50 | mA |
| | | | 1 | +125°C | - | 45 | - | 45 | mA |
| | | | 1 | -55°C | - | 60 | - | 60 | mA |
| | $-I_{SC}$ | $V_{OUT} = -1V$, $R_L = 10\Omega$ | 1 | +25°C | -50 | - | -50 | - | mA |
| | | | 1 | +125°C | -45 | - | -45 | - | mA |
| | | | 1 | -55°C | -60 | | -60 | - | mA |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 120 | - | 120 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
69 x 56 x 19 mils ± 1 mils
1750 x 1420 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.9 \times 10^4 A/cm^2$

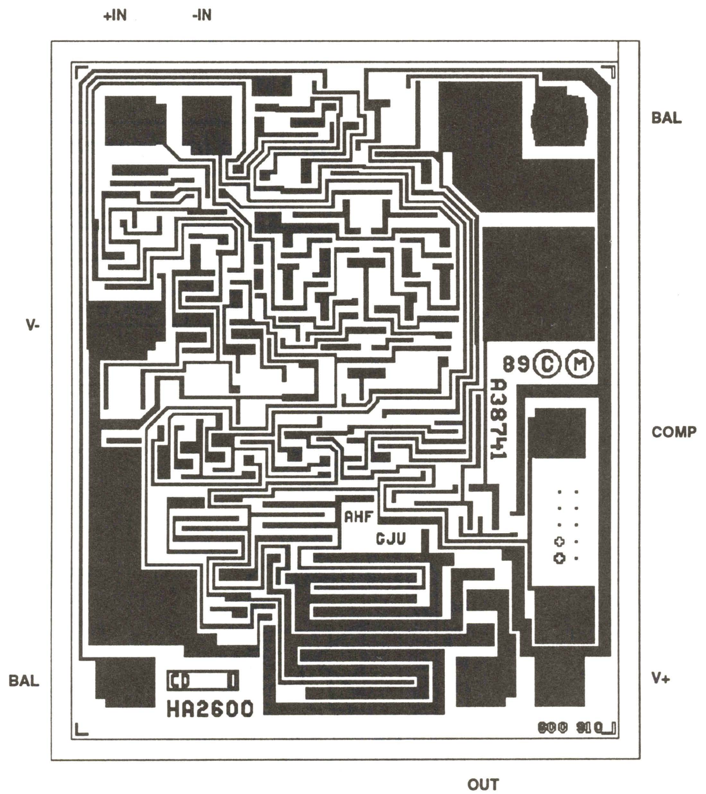
**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

**TRANSISTOR COUNT:**
HA-2600/883: 140
HA-2602/883: 140

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

**HA-2600/883, HA-2602/883**



# HA-2640/883

July 1994

## High Voltage Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Output Voltage Swing .................. ±35V (Min)
- Supply Voltage ................. ±10V to ±40V (Min)
- Slew Rate .......................... 3V/µs (Min)
- Common Mode Input Voltage Swing ...... ±35V (Min)
- Offset Current....................... 12nA (Max)
- Unity Gain Bandwidth ................. 5MHz (Typ)
- Output Overload Protection

### Applications

- Industrial Control Systems
- Power Supplies
- High Voltage Regulators
- Resolver Excitation
- Signal Conditioning

### Description

HA-2640/883 monolithic operational amplifier is designed to deliver unprecedented dynamic specification for a high voltage internally compensated device. This dielectrically isolated device offer very low values for offset voltage and offset current coupled with large output voltage swing and common mode input voltage.

For maximum reliability, the HA-2640/883 offers unconditional output overload protection through output short circuit current limiting. This circuitry will limit the output to typically ±25mA output drive current.

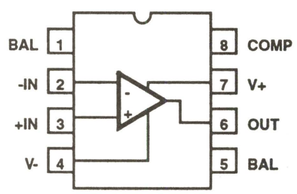
These amplifiers deliver ±35V common mode input voltage swing, ±35V output voltage swing, and up to ±40V supply range for use in such designs as regulators, power supplies, and industrial control systems. The 5MHz typical gain-bandwidth product and 5V/µs slew rate (typ) make these devices excellent components for high performance signal conditioning applications. To insure compliance, all devices are 100% tested for slew rate, rise/fall time and overshoot. Outstanding input and output voltage swings coupled with a low 5nA offset current (typ), make these amplifiers excellent components for resolver excitation designs.

### Ordering Information

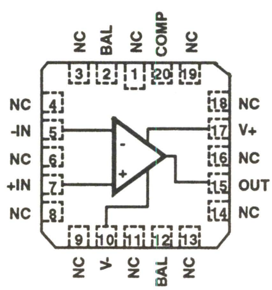
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-2640/883 | -55°C to +125°C | 8 Pin Can |
| HA4-2640/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-2640/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

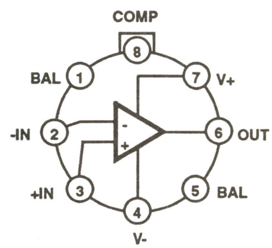
HA-2640/883
(CERDIP)
TOP VIEW




HA-2640/883
(CLCC)
TOP VIEW




HA-2640/883
(METAL CAN)




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 100V
Differential Input Voltage .............................. 37V
Output Current .................... Full Short Circuit Protection
Output Short Circuit Duration ...................... 5 Seconds
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating ......................................... <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package .............................. 870mW
Ceramic LCC Package .......................... 1.54W
Metal Can Package ............................ 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .............................. 8.7mW/°C
Ceramic LCC Package ......................... 15.4mW/°C
Metal Can Package ............................ 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ........................ ±10V to ±40V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 500\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±40V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -4 | 4 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100Ω | 1 | +25°C | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100kΩ | 1 | +25°C | -25 | 25 | nA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100kΩ, $-R_S$ = 100kΩ | 1 | +25°C | -12 | 12 | nA |
| | | | 2, 3 | +125°C, -55°C | -35 | 35 | nA |
| Common Mode Range | +CMR | V+ = 15V, V- = -65V | 1 | +25°C | 25 | - | V |
| | | | 2, 3 | +125°C, -55°C | 25 | - | V |
| | -CMR | V+ = 65V, V- = -15V | 1 | +25°C | - | -25 | V |
| | | | 2, 3 | +125°C, -55°C | - | -25 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +30V, $R_L$ = 5kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 75 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -30V, $R_L$ = 5kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 75 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +20V, V+ = +20V, V- = -60V, $V_{OUT}$ = -20V | 4 | +25°C | 80 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 80 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -20V, V+ = +60V, V- = -20V, $V_{OUT}$ = +20V | 4 | +25°C | 80 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 80 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±40V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 5kΩ | 1 | +25°C | 35 | - | V |
| | | | 2, 3 | +125°C, -55°C | 35 | - | V |
| | $-V_{OUT}$ | $R_L$ = 5kΩ | 1 | +25°C | - | -35 | V |
| | | | 2, 3 | +125°C, -55°C | - | -35 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 12 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -12 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 3.8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4.0 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -3.8 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4.0 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 30V, V+ = +10V, V- = -40V, V+ = +40V, V- = -40V | 4 | +25°C | 80 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 80 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 30V, V+ = +40V, V- = -10V, V+ = +40V, V- = -40V | 4 | +25°C | 80 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 80 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±40V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 5kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 4 | +25°C | 3 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 4 | +25°C | 3 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 4 | +25°C | - | 135 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 4 | +25°C | - | 135 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 4 | +25°C | - | 30 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 4 | +25°C | - | 30 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±40V, $R_{LOAD}$ = 5kΩ, $C_{LOAD}$ = 10pF, $A_V$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 50 | - | MΩ |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 45 | - | kHz |
| | | $V_{PEAK}$ = 35V | 1, 2 | +25°C | 13.6 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 5kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | 1 | - | V/V |
| Output Short Circuit Current | $+I_{SC}$ | $V_{OUT}$ = 0V, $R_L$ = 10Ω | 1 | +25°C | - | 25 | mA |
| | $-I_{SC}$ | $V_{OUT}$ = 0V, $R_L$ = 10Ω | 1 | +25°C | -25 | - | mA |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 600 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 320 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## *Die Characteristics*

**DIE DIMENSIONS:**
93 x 68 x 19 mils ± 1 mils
2360 x 1720 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$5.0 \times 10^4$ A/cm$^2$ at 12mA

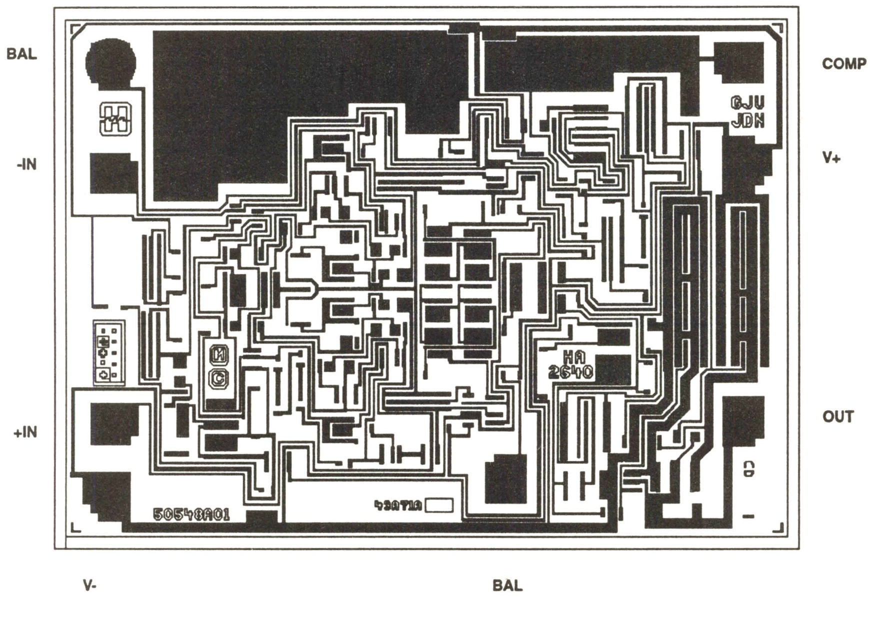
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 76

**PROCESS:** HV200 Bipolar Dielectric Isolation

## *Metallization Mask Layout*

HA-2640/883



HARRIS SEMICONDUCTOR

# HA-2839/883

## Very High Slew Rate, Wideband Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Supply Current . . . . . . . . . . . . . . . . . . . . . 15.0mA (Max)
- Low Offset Voltage . . . . . . . . . . . . . . . . . . . 2.0mV (Max)
- Very High Slew Rate . . . . . . . . . . . . . . . . 600V/µs (Typ)
- Open Loop Gain . . . . . . . . . . . . . . . . . . . . . 20kV/V (Min)
- Wide Gain-Bandwidth ($A_V \geq 10$) . . . . . . . 600MHz (Typ)
- Input Noise Voltage at 1kHz . . . . . . . . . . $6nV/\sqrt{Hz}$ (Typ)
- Enhanced Replacement for HA-2539/883 and EL2039

### Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- High Speed Sample-Hold Circuits
- Fast, Precise D/A Converters
- RF Oscillators

### Description

The HA-2839/883 is a wideband, very high slew rate, operational amplifier featuring superior speed and bandwidth characteristics. It also features trimmed supply current, which minimizes supply current (and thus A.C. parameter) variation over process and temperature extremes. For example, the $I_{CC}$ variation over the entire military temperature range is typically less than 0.5mA. Bipolar construction, coupled with dielectric isolation, delivers outstanding performance in circuits with closed loop gains ≥10.

The 600V/µs slew rate, and 600MHz gain bandwidth product ensure high performance in video and wideband amplifier designs. Differential gain and phase are a low 0.03% and 0.03 degrees, respectively, making the HA-2839/883 ideal for video applications. A full ±10V output swing, high open loop gain, and outstanding A.C. parameters make the HA-2839/883 an excellent choice for data acquisition systems.

### Ordering Information

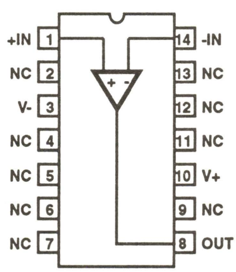
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2839/883 | -55°C to +125°C | 14 Lead CerDIP |

3

OPERATIONAL AMPLIFIERS

### Pinout

HA-2839/883
(CERDIP)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511089-883**
File Number **3593.1**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 35V
Differential Input Voltage.................................. 6V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current (≤ 10% Duty Cycle)................. 50mA
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating......................................... <2000V
Lead Temperature (Soldering 10 seconds) ............. +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| 14 Lead CerDIP Package | 81°C/W | 26°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
14 Lead CerDIP Package ........................... 1.23W
Package Power Dissipation Derating Factor Above +75°C
14 Lead CerDIP Package ..................... 12.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage........................ ±12V to ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq$ 1kΩ

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| DC PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 100Ω | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω $-R_S$ = 1.1kΩ | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 1.1kΩ | 1 | +25°C | -4 | 4 | µA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µA |
| Common Mode Range | +CMR | V+ = 5V V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V $R_L$ = 1kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V $R_L$ = 1kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, $V_{OUT}$ = -10V V+ = 5V, V- = -25V | 1 | +25°C | 75 | - | dB |
| | | | 2,3 | +125°C, -55°C | 75 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, $V_{OUT}$ = 10V V+ = 25V, V- = -5V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| DC PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = 10V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = -10V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | - | 14.6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 15 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | -14.6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -15 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V<br>V+ = 10V, V- = -15V<br>V+ = 20V, V- = -15V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V<br>V+ = 15V, V- = -10V<br>V+ = 15V, V- = -20V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

3 OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_L$ ≤10pF, $A_V$ = +10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 5MHz | 1 | +25°C | 500 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 45MHz | 1 | +25°C | 450 | - | MHz |
| Slew Rate | +SR | $V_O$ = -5V to +5V | 1, 4 | +25°C | 550 | - | V/µs |
| | -SR | $V_O$ = +5V to -5V | 1, 4 | +25°C | 500 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 8.0 | - | MHz |
| Rise and Fall Time | $T_R$ | $V_O$ = 0V to +200mV | 1, 4 | +25°C | - | 10 | ns |
| | $T_F$ | $V_O$ = 0V to -200mV | 1, 4 | +25°C | - | 10 | ns |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 1kΩ, $C_L$ ≤ 10pF | 1 | -55°C to +125°C | 10 | - | V/V |
| Overshoot | +OS | $V_O$ = 0V to +200mV | 1 | +25°C | - | 30 | % |
| | -OS | $V_O$ = 0V to -200mV | 1 | +25°C | - | 30 | % |
| Open Loop Output Resistance | $R_{OUT}$ | $V_{OUT}$ = 0V | 1 | +25°C | - | 60 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 450 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
65 x 52 x 19 mils ± 1 mils
1650 x 1310 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Aluminum, 1% Copper
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Al, 1% Cu
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.3 \times 10^5$ A/cm$^2$ at 3.4mA

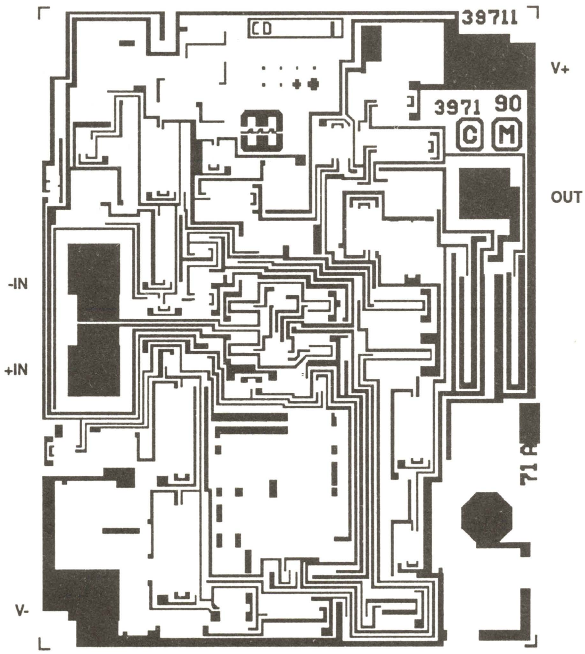
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 34

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2839/883



# HARRIS SEMICONDUCTOR

# HA-2840/883

## Very High Slew Rate, Wideband Operational Amplifier

July 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Supply Current ..................... 15.0mA (Max)**
- **Low Offset Voltage ................... 2.0mV (Max)**
- **Very High Slew Rate ................ 600V/µs (Typ)**
- **Open Loop Gain ..................... 20kV/V (Min)**
- **Wide Gain-Bandwidth ($A_V \geq 10$) ....... 600MHz (Typ)**
- **Input Noise Voltage at 1kHz .......... 6nV/$\sqrt{Hz}$ (Typ)**
- **Enhanced Replacement for HA-2540/883 and AD840**

### Applications

- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **RF/IF Signal Processing**
- **High Speed Sample-Hold Circuits**
- **Fast, Precise D/A Converters**
- **RF Oscillators**

### Description

The HA-2840/883 is a wideband, very high slew rate, operational amplifier featuring superior speed and bandwidth characteristics. It also features trimmed supply current, which minimizes supply current (and thus A.C. parameter) variation over process and temperature extremes. For example, the $I_{CC}$ variation over the entire military temperature range is typically less than 0.5mA. Bipolar construction, coupled with dielectric isolation, delivers outstanding performance in circuits with closed loop gains ≥10.

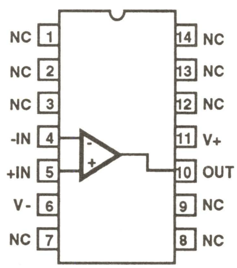
The 600V/µs slew rate, and 600MHz gain bandwidth product ensure high performance in video and wideband amplifier designs. Differential gain and phase are a low 0.03% and 0.03 degrees, respectively, making the HA-2840/883 ideal for video applications. A full ±10V output swing, high open loop gain, and outstanding A.C. parameters make the HA2840/883 an excellent choice for data acquisition systems.

### Ordering Information

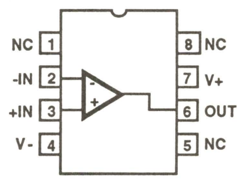
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2840/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA7-2840/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

**HA-2840/883**
**(CERDIP)**
TOP VIEW




**HA-2840/883**
**(CERDIP)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511090-883**
File Number **3594.1**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 35V
Differential Input Voltage ................................ 6V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current (≤10% Duty Cycle) ................. 50mA
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating ........................................ <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| 14 Lead CerDIP Package | 81°C/W | 26°C/W |
| 8 Lead CerDIP Package | 115°C/W | 30°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
14 Lead CerDIP Package ........................... 1.23W
8 Lead CerDIP Package ............................ 0.87W
Package Power Dissipation Derating Factor Above +75°C
14 Lead CerDIP Package ....................... 12.3mW/°C
8 Lead CerDIP Package ......................... 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ......................... ±12V to ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ, $-R_S$ = 100Ω | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 1.1kΩ | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ, $-R_S$ = 1.1kΩ | 1 | +25°C | -4 | 4 | µA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 1kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 1kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, $V_{OUT}$ = -10V, V+ = 5V, V- = -25V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, $V_{OUT}$ = 10V, V+ = 25V, V- = -5V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = 10V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = -10V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 14.6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 15 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -14.6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -15 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = 10V, V- = -15V, V+ = 20V, V- = -15V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = 15V, V- = -10V, V+ = 15V, V- = -20V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_L \leq$ 10pF, $A_V$ = +10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 5MHz | 1 | +25°C | 500 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 45MHz | 1 | +25°C | 450 | - | MHz |
| Slew Rate | +SR | $V_O$ = -5V to +5V | 1, 4 | +25°C | 550 | - | V/µs |
| | -SR | $V_O$ = +5V to -5V | 1, 4 | +25°C | 500 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 8.0 | - | MHz |
| Rise and Fall Time | $T_R$ | $V_O$ = 0V to +200mV | 1, 4 | +25°C | - | 10 | ns |
| | $T_F$ | $V_O$ = 0V to -200mV | 1, 4 | +25°C | - | 10 | ns |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 1kΩ, $C_L \leq$ 10pF | 1 | -55°C to +125°C | 10 | - | V/V |
| Overshoot | +OS | $V_O$ = 0V to +200mV | 1 | +25°C | - | 30 | % |
| | -OS | $V_O$ = 0V to -200mV | 1 | +25°C | - | 30 | % |
| Open Loop Output Resistance | $R_{OUT}$ | $V_{OUT}$ = 0V | 1 | +25°C | - | 60 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 450 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

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OPERATIONAL AMPLIFIERS

## Die Characteristics

**DIE DIMENSIONS:**
65 x 52 x 19 mils ± 1 mils
1650 x 1310 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.3 \times 10^5$ A/cm$^2$ at 3.4mA

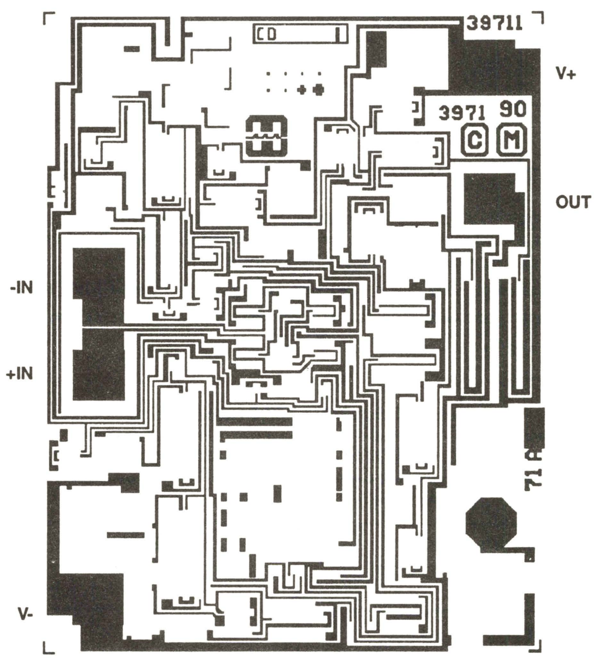
**SUBSTRATE POTENTIAL (Powered UP):** V-

**TRANSISTOR COUNT:** 34

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2840/883



HARRIS
SEMICONDUCTOR

# HA-2841/883

## Wideband, Fast Settling, Unity Gain Stable, Video Operational Amplifier

July 1994



### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1
- Low AC Variability Over Process and Temperature
- Low Supply Current. . . . . . . . . . . . . . . . . . . 11mA (Max)
- Unity Gain Bandwidth . . . . . . . . . . . . . . . . 50MHz (Typ)
- High Slew Rate. . . . . . . . . . . . . . . . . . . . . 290V/µs (Typ)
- Low Offset Voltage. . . . . . . . . . . . . . . . . . . . 1mV (Typ)
- Full Power Bandwidth . . . . . . . . . . . . . . . . 4.6MHz (Typ)
- Low Differential Gain/Phase . . . . . . . 0.03%/0.03° (Typ)

### Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- Fast Sample and Hold Circuits
- Fast, Precise D/A Converters
- High Speed A/D Input Buffer

### Description

The HA-2841/883 is a wideband, unity gain stable, operational amplifier featuring a 50MHz unity gain bandwidth, and excellent DC specifications. This amplifier's performance is further enhanced through stable operation down to closed loop gains of +1, the inclusion of offset null controls, and by its excellent video performance.

The capabilities of the HA-2841/883 are ideally suited for high speed pulse and video amplifier circuits, where high slew rates and wide bandwidth are required. Gain flatness of 0.05dB, combined with differential gain and phase specifications of 0.03%, and 0.03 degrees, respectively, make the HA-2841/883 ideal for component and composite video applications.

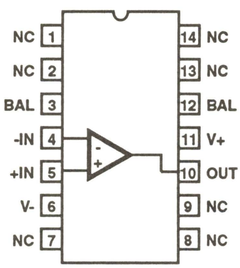
A zener/nichrome based reference circuit, coupled with advanced laser trimming techniques, yields a supply current with a low temperature coefficient and low lot-to-lot variability. Tighter $I_{CC}$ control translates to more consistent AC parameters ensuring that units from each lot perform the same way, and easing the task of designing systems for wide temperature ranges.

### Ordering Information

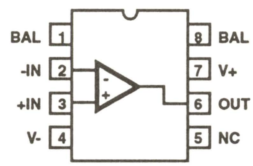
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2841/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA7-2841/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

HA-2841/883
(CERDIP)
TOP VIEW




HA-2841/883
(CERDIP)
TOP VIEW




NOTE: (NC) No Connection pins may be tied to a ground plane for better isolation and heat dissipation.

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511087-883
File Number 3621.1

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals . . . . . . +35V
Differential Input Voltage . . . . . . 6V
Voltage at Either Input Terminal . . . . . . V+ to V-
Peak Output Current (≤10% Duty Cycle) . . . . . . 50mA
Junction Temperature ($T_J$) . . . . . . +175°C
Storage Temperature Range . . . . . . -65°C to +150°C
ESD Rating . . . . . . <2000V
Lead Temperature (Soldering 10s) . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| 14 Pin CerDIP Package | 73°C/W | 18°C/W |
| 8 Pin CerDIP Package | 110°C/W | 27°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
14 Pin CerDIP Package . . . . . . 1.05W
8 Pin CerDIP Package . . . . . . 0.9W
Package Power Dissipation Derating Factor Above +75°C
14 Pin CerDIP Package . . . . . . 10.5mW/°C
8 Pin CerDIP Package . . . . . . 9mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range . . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . . ±12V to ±15V
$V_{INCM} \leq 1/2(V+ - V-)$
$R_L \geq 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -4 | 4 | mV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 100Ω | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω $-R_S$ = 1.1kΩ | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 1.1kΩ | 1 | +25°C | -1 | 1 | µA |
| | | | 2, 3 | +125°C, -55°C | -2 | 2 | µA |
| Common Mode Range | +CMR | V+ = 5V V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V $R_L$ = 1kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 5 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V $R_L$ = 1kΩ | 4 | +25°C | 10 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 5 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, $V_{OUT}$ = -10V V+ = 5V, V- = -25V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, $V_{OUT}$ = 10V V+ = 25V, V- = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -5V, (Note 1) | 1 | +25°C | 25 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 15 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = 5V, (Note 1) | 1 | +25°C | - | -25 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -15 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | - | 11 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 11 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | -11 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -11 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUPPLY}$ = 10V<br>V+ = 10V, V- = -15V<br>V+ = 20V, V- = -15V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| | -PSRR | $\Delta V_{SUPPLY}$ = 10V<br>V+ = 15V, V- = -10V<br>V+ = 15V, V- = -20V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | (Note 2) | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | (Note 2) | 1 | +25°C | $V_{IO}$+1 | - | mV |

NOTES:

1. The output metal is sized to handle $I_{OUT}$ = 10mA at a 50% duty cycle, for $T_J$ = +175°C. For $I_{OUT}$ = 15mA and $T_J$ = +175°C, a duty cycle ≤33% is required.
2. Offset Adjustment range is $|V_{IO}$ (measured) ±1mV$|$ minimum referred to output. This test is for functionality only, to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $V_{OUT}$ = 0V, $A_V$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 0.1MHz | 1 | +25°C | 42 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 10MHz | 1 | +25°C | 44 | - | MHz |
| Slew Rate | SR | $V_O$ = -3V to +3V | 1, 3 | +25°C | 200 | - | V/µs |
| | SR | $V_O$ = -3V to +3V | 1, 3 | -55°C to +125°C | 187 | - | V/µs |
| Rise Time | $T_R$ | $V_O$ = 0V to +200mV $C_L$ < 10pF | 1, 3 | +25°C | - | 6 | ns |
| | | | 1, 3 | -55°C to +125°C | - | 6 | ns |
| Fall Time | $T_F$ | $V_O$ = 0V to -200mV $C_L$ < 10pF | 1, 3 | +25°C | - | 5 | ns |
| | | | 1, 3 | -55°C to +125°C | - | 6 | ns |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = +10V | 1, 2 | +25°C | 3.1 | - | MHz |
| | | | 1, 2 | -55°C to +125°C | 3.0 | - | MHz |
| Overshoot | +OS | $V_O$ = 0V to +200mV | 1 | +25°C | - | 60 | % |
| | | | 1 | -55°C to +125°C | - | 65 | % |
| | -OS | $V_O$ = 0V to -200mV | 1 | +25°C | - | 60 | % |
| | | | 1 | -55°C to +125°C | - | 70 | % |
| Closed Loop Output Resistance | $R_{OUT}$ | $A_V$ > +1 $V_M$ = 10V, ΔI = 9mA | 1 | +25°C | - | 1 | Ω |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variations.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
77 x 81 x 19 mils ± 1 mils
1960 x 2060 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride thickness: 3.5kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.2 \times 10^5$ A/cm$^2$ at 9.7mA

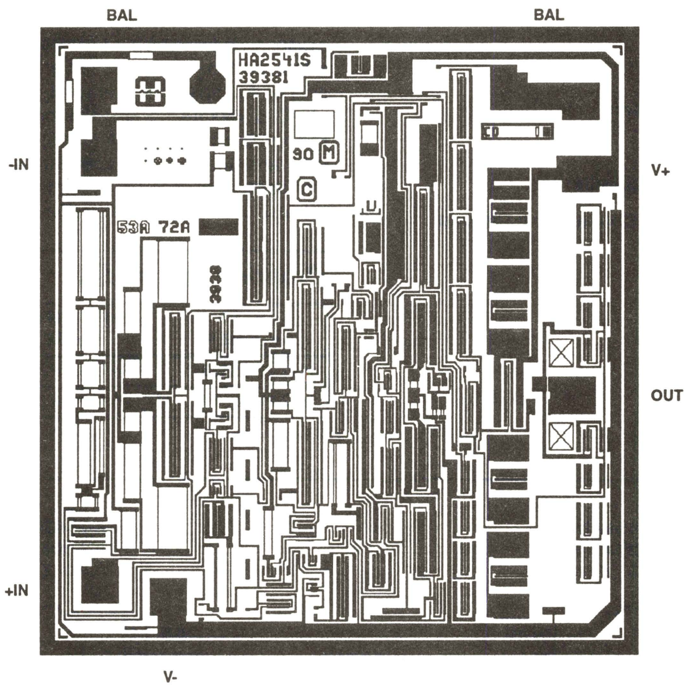
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 43

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2841/883




3 OPERATIONAL AMPLIFIERS

HARRIS SEMICONDUCTOR

# HA-2842/883

## Wideband, High Slew Rate, High Output Current, Video Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low AC Variability Over Process and Temperature
- Stable at Gains of 2 or Greater
- Low Supply Current . . . . . . . . . . . . . . . . . . 15mA (Max)
- Gain Bandwidth Product . . . . . . . . . . . . . . 80MHz (Typ)
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . 375V/µs (Typ)
- High Output Current . . . . . . . . . . . . . . . . . 100mA (Min)
- Full Power Bandwidth . . . . . . . . . . . . . . . . . 6MHz (Typ)
- Low Differential Gain/Phase . . . . . . . 0.02%/0.03° (Typ)

### Applications

- Coaxial Cable Drivers
- Pulse and Video Amplifiers
- Wideband Amplifiers
- Fast Sample and Hold Circuits
- High Frequency Signal Conditioning Circuits

### Description

The HA-2842/883 is a wideband, high slew rate, operational amplifier featuring an outstanding combination of speed, bandwidth, and output drive capability. This amplifier's performance is further enhanced through stable operation down to closed loop gains of +2, the inclusion of offset null controls, and by its excellent video performance.

The capabilities of the HA-2842/883 are ideally suited for high speed cable driver circuits, where low closed loop gains and high output drive are required. With a 6MHz full power bandwidth, this amplifier is well suited for high frequency signal conditioning circuits and video amplifiers. Gain flatness of 0.035dB, combined with differential gain and phase specifications of 0.02%, and 0.03 degrees, respectively, make the HA-2842/883 ideal for component and composite video applications.

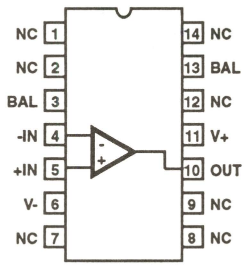
A zener/nichrome based reference circuit, coupled with advanced laser trimming techniques, yields a supply current with a low temperature coefficient and low lot-to-lot variability. For example, the average $I_{CC}$ variation from +85°C to -40°C is <600µA (±2%),while the standard deviation of the $I_{CC}$ distribution is <0.1mA (0.8%) at +25°C. Tighter $I_{CC}$ control translates to more consistent AC parameters ensuring that units from each lot perform the same way, and easing the task of designing systems for wide temperature ranges.

### Ordering Information

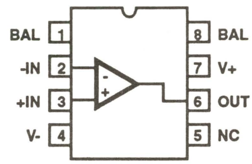
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2842/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA7-2842/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

HA-2842/883
(CERDIP)
TOP VIEW




HA-2842/883
(CERDIP)
TOP VIEW




NOTE: (NC) No Connection pins may be tied to a ground plane for better isolation and heat dissipation.

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511088-883**
File Number **3622.1**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals. . . . . . . . . . . . . . . . . . . . 35V
Differential Input Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6V
Voltage at Either Input Terminal. . . . . . . . . . . . . . . . . . . . . . V+ to V-
Peak Output Current (≤40% Duty Cycle) . . . . . . . . . . . . . . . . 125mA
Junction Temperature ($T_J$) (Note 1) . . . . . . . . . . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . . . . . . . . . -65°C to +150°C
ESD Rating. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . <2000V
Lead Temperature (Soldering 10s). . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| 14 Lead CerDIP Package | 73°C/W | 18°C/W |
| 8 Lead CerDIP Package | 110°C/W | 27°C/W |

Package Power Dissipation Limit at +75°C for $T_J \le$ +175°C
14 Lead CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . 1.1W
8 Lead CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0.9W
Package Power Dissipation Derating Factor Above +75°C
14 Lead CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . 11mW/°C
8 Lead CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . 9mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range. . . . . . . . . . . . . . . . . -55°C to +125°C
Operating Supply Voltage. . . . . . . . . . . . . . . . . . . . . . . . ±12V to ±15V
$V_{INCM} \le 1/2(V+ - V-)$
$R_L \ge 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -4 | 4 | mV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 100Ω | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω $-R_S$ = 1.1kΩ | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 1.1kΩ $-R_S$ = 1.1kΩ | 1 | +25°C | -1 | 1 | µA |
| | | | 2, 3 | +125°C, -55°C | -2 | 2 | µA |
| Common Mode Range | +CMR | V+ = 5V V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V $R_L$ = 1kΩ | 4 | +25°C | 50 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 30 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V $R_L$ = 1kΩ | 4 | +25°C | 50 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 30 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, $V_{OUT}$ = -10V V+ = 5V, V- = -25V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 85 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, $V_{OUT}$ = 10V V+ = 25V, V- = -5V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 85 | - | dB |

3
OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -5V<br>Note 1 | 1 | +25°C | 100 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 100 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +5V<br>Note 1 | 1 | +25°C | - | -100 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -100 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | - | 15 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 15 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V<br>$I_{OUT}$ = 0mA | 1 | +25°C | -15 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -15 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUPPLY}$ = 10V<br>V+ = 10V, V- = -15V<br>V+ = 20V, V- = -15V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| | -PSRR | $\Delta V_{SUPPLY}$ = 10V<br>V+ = 15V, V- = -10V<br>V+ = 15V, V- = -20V | 1 | +25°C | 70 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 70 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}$Adj | Note 2 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | $+V_{IO}$Adj | Note 2 | 1 | +25°C | $V_{IO}$+1 | - | mV |

NOTES:

1. Maximum power dissipation, including output load conditions, must be designed to maintain the maximum junction temperature below +175°C. For a 100mA load and a +125°C ambient, heat sinking is required.
2. Offset Adjustment range is $|V_{IO}$ (measured) ±1mV$|$ minimum referred to output. This test is for functionality only, to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $V_{OUT}$ = 0V, $A_V$ = +2V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 100kHz | 1 | +25°C | 60 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 10MHz | 1 | +25°C | 70 | - | MHz |
| Slew Rate | +SR | $V_O$ = -5V to +5V | 1, 3 | +25°C, -55°C | 350 | - | V/µs |
| | | | 1, 3 | +125°C | 300 | - | V/µs |
| | -SR | $V_O$ = +5V to -5V | 1, 3 | +25°C, -55°C | 350 | - | V/µs |
| | | | 1, 3 | +125°C | 300 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = +10V | 1, 2 | +25°C, -55°C | 5.5 | - | MHz |
| | | | 1, 2 | +125°C | 4.7 | - | MHz |
| Rise Time | $T_R$ | $V_O$ = 0V to +200mV $C_L \leq$ 10pF | 1, 3 | +25°C | - | 5 | ns |
| | | | 1, 3 | -55°C to +125°C | - | 7 | ns |
| Fall Time | $T_F$ | $V_O$ = 0V to -200mV $C_L \leq$ 10pF | 1, 3 | +25°C | - | 5 | ns |
| | | | 1, 3 | -55°C to +125°C | - | 5 | ns |
| Overshoot | +OS | $V_O$ = 0V to +200mV | 1 | +25°C | - | 50 | % |
| | | | 1 | -55°C to +125°C | - | 55 | % |
| | -OS | $V_O$ = 0V to -200mV | 1 | +25°C | - | 50 | % |
| | | | 1 | -55°C to +125°C | - | 55 | % |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variations.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

3 OPERATIONAL AMPLIFIERS

## Die Characteristics

**DIE DIMENSIONS:**
77 x 81 x 19 mils ± 1 mils
1960 x 2060 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.83 \times 10^5$ A/cm$^2$ at 56mA

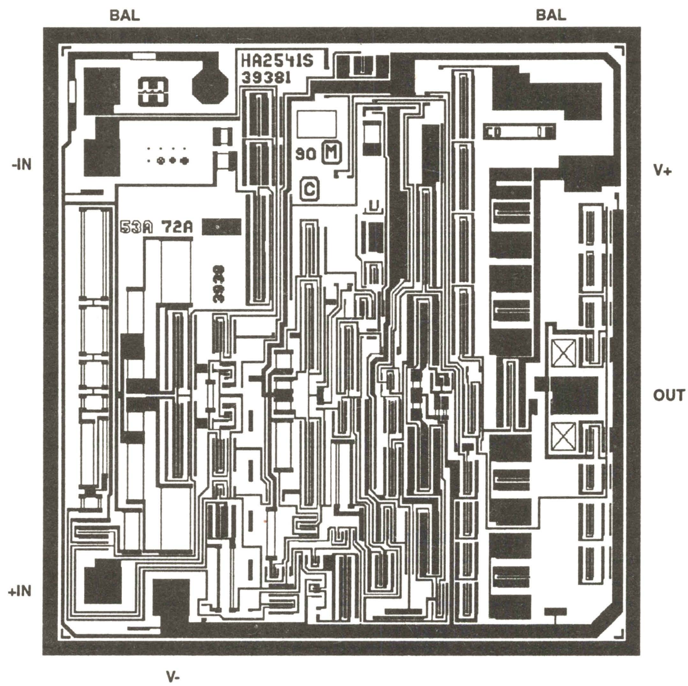
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 58

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2842/883



HARRIS SEMICONDUCTOR

# HA-2850/883

## Low Power, High Slew Rate, Wideband Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Supply Current.................. 8.0mA (Max)
- Low Offset Voltage.................... 2.0mV (Max)
- High Slew Rate..................... 340V/µs (Typ)
- Open Loop Gain..................... 20kV/V (Min)
- Wide Gain-Bandwidth ($A_V \geq 10$) ....... 470MHz (Typ)
- Input Noise Voltage at 1kHz ......... 11nV/$\sqrt{Hz}$ (Typ)
- Lower Power Replacement for HA-2540/883, AD840

### Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- High Speed Sample-Hold Circuits
- Fast, Precise D/A Converters

### Description

The HA-2850/883 is a wideband, high slew rate, operational amplifier featuring superior speed and bandwidth characteristics. It also features trimmed supply current, which minimizes supply current (and thus AC parameter) variation over process and temperature extremes. For example, the $I_{CC}$ variation over the entire military temperature range is typically less than 0.5mA. Bipolar construction, coupled with dielectric isolation, delivers outstanding performance in circuits with closed loop gains ≥10.

The 340V/µs slew rate, and 470MHz gain bandwidth product ensure high performance in video and wideband amplifier designs. Differential gain and phase are a low 0.04% and 0.04 degrees, respectively, making the HA-2850/883 ideal for video applications. A full ±10V output swing, high open loop gain, and outstanding AC parameters make the HA-2850/883 an excellent choice for data acquisition systems.

### Ordering Information

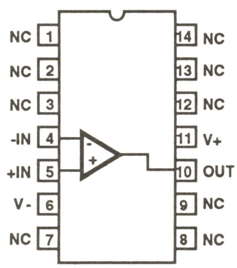
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2850/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA7-2850/883 | -55°C to +125°C | 8 Lead CerDIP |

3

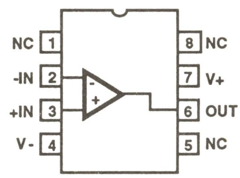
OPERATIONAL AMPLIFIERS

### Pinouts

HA-2850/883
(CERDIP)
TOP VIEW




HA-2850/883
(CERDIP)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511095-883
File Number 3595.1

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 35V
Differential Input Voltage.................................. 6V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current (≤10% Duty Cycle) ................. 50mA
Junction Temperature ($T_J$) ........................... +175°C
Storage Temperature Range .................. -65°C to +150°C
ESD Classification ................................. <2000V
Lead Temperature (Soldering 10s)..................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| 14 Lead CerDIP Package | 81°C/W | 26°C/W |
| 8 Lead CerDIP Package | 115°C/W | 30°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
14 Lead CerDIP Package ........................... 1.23W
8 Lead CerDIP Package ............................ 0.87W
Package Power Dissipation Derating Factor Above +75°C
14 Lead CerDIP Package ...................... 12.3mW/°C
8 Lead CerDIP Package ........................ 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage........................ ±12V to ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 1k\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | mV |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S = 1.1k\Omega$ $-R_S = 100\Omega$ | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S = 100\Omega$ $-R_S = 1.1k\Omega$ | 1 | +25°C | -14.5 | 14.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S = 1.1k\Omega$ $-R_S = 1.1k\Omega$ | 1 | +25°C | -4 | 4 | µA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µA |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V $R_L = 1k\Omega$ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V $R_L = 1k\Omega$ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, $V_{OUT}$ = -10V V+ = 5V, V- = -25V | 1 | +25°C | 75 | - | dB |
| | | | 2,3 | +125°C, -55°C | 75 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, $V_{OUT}$ = 10V V+ = 25V, V- = -5V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = 10V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = -10V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 8 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -8 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -8 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V<br>V+ = 10V, V- = -15V<br>V+ = 20V, V- = -15V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V<br>V+ = 15V, V- = -10V<br>V+ = 15V, V- = -20V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 1kΩ, $C_L$ ≤ 10pF, $A_V$ = +10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O$ = 200mV, $f_O$ = 5MHz | 1 | +25°C | 400 | - | MHz |
| | | $V_O$ = 200mV, $f_O$ = 45MHz | 1 | +25°C | 350 | - | MHz |
| Slew Rate | +SR | $V_O$ = -5V to +5V | 1, 4 | +25°C | 300 | - | V/µs |
| | -SR | $V_O$ = +5V to -5V | 1, 4 | +25°C | 300 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 4.8 | - | MHz |
| Rise and Fall Time | $T_R$ | $V_O$ = 0V to +200mV | 1, 4 | +25°C | - | 15 | ns |
| | $T_F$ | $V_O$ = 0V to -200mV | 1, 4 | +25°C | - | 15 | ns |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 1kΩ, $C_L$ ≤ 10pF | 1 | -55°C to +125°C | 10 | - | V/V |
| Overshoot | +OS | $V_O$ = 0V to +200mV | 1 | +25°C | - | 30 | % |
| | -OS | $V_O$ = 0V to -200mV | 1 | +25°C | - | 30 | % |
| Open Loop Output Resistance | $R_{OUT}$ | $V_{OUT}$ = 0V | 1 | +25°C | - | 60 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 240 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

65 x 52 x 19 mils ± 1 mils
1650 x 1310 x 483µm ± 25.4µm

**METALLIZATION:**

Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**

Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**

$0.7 \times 10^5$ A/cm$^2$ at 1.8mA

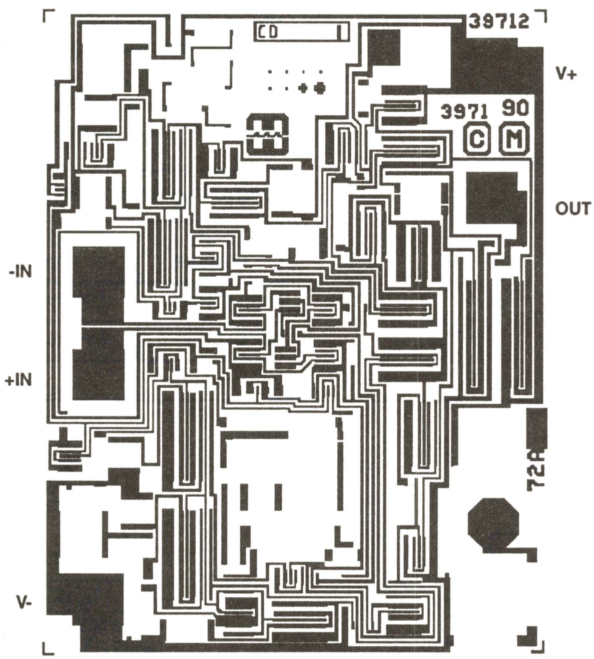
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 34

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2850/883



# HARRIS SEMICONDUCTOR

# HA-4741/883

July 1994

## Quad Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Slew Rate .......................... 0.9V/µs (Min)
- Bandwidth.......................... 2.5MHz (Min)
- Input Offset Voltage .................... 3mV (Max)
- Input Bias Current .................... 200nA (Max)
- Input Voltage Noise .................. 9nV/√Hz (Typ)
- No Crossover Distortion
- Standard Quad Pinout

### Applications

- Universal Active Filters
- D3 Communications Filters
- Audio Amplifiers
- Battery-Powered Equipment

### Description

The Harris HA-4741/883, which contains four amplifiers on a monolithic chip, provides a new measure of performance for general purpose operational amplifiers. Each amplifier in the HA-4741/883 has operating specifications that equal or exceed those of the 741-type amplifier in all categories of performance.

The HA-4741/883 is well suited to applications requiring accurate signal processing by virtue of its low values of input offset voltage (3mV max), input bias current (200nA max) and input voltage noise (9nV/√Hz typ at 1kHz). The 2.5MHz bandwidth, coupled with high open loop gain, allow the HA-4741/883 to be used in designs requiring amplifiers of wideband signals, such as audio amplifiers. Audio application is further enhanced by the HA-4741/883's negligible output crossover distortion. These excellent dynamic characteristics also make the HA-4741/883 ideal for a wide range of active filter designs. Performance integrity of multi-channel designs is assured by a high level of amplifier-to-amplifier isolation (66dB at 10kHz).

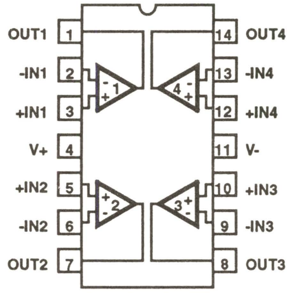
A wide range of supply voltages (±2V to ±20V) can be used to power the HA-4741/883, making it compatible with almost any system including battery-powered equipment.

### Ordering Information

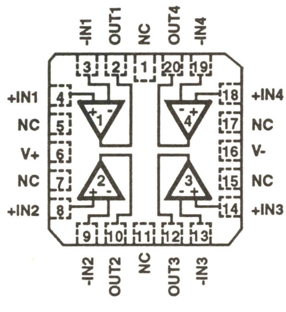
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-4741/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-4741/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HA-4741/883
(CERDIP)
TOP VIEW




HA-4741/883
(CLCC)
TOP VIEW








Spec Number 511007-883
File Number 3704

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals . . . . . 40V
Differential Input Voltage. . . . . 15V
Voltage at Either Input Terminal . . . . . V+ to V-
Output Current . . . . . Indefinite (One Amplifier Shorted to GND)
Junction Temperature ($T_J$) . . . . . +175°C
Storage Temperature Range . . . . . -65°C to +150°C
ESD Rating. . . . . <2000V
Lead Temperature (Soldering 10s). . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package . . . . . 1.33W
Ceramic LCC Package . . . . . 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 13.3mW/°C
Ceramic LCC Package . . . . . 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range. . . . . -55°C to +125°C
Operating Supply Voltage. . . . . ±5V to ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -3 | 3 | mV |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -30 | 30 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| Common Mode Range | +CMR | V+ = 3V, V- = -27V | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | -CMR | V+ = 27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 50 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 25 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 50 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 25 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = -10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 74 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = +10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 74 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT1}$ | $R_L = 10k\Omega$ | 4 | +25°C | 12 | - | V |
| | | | 5, 6 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT1}$ | $R_L = 10k\Omega$ | 4 | +25°C | - | -12 | V |
| | | | 5, 6 | +125°C, -55°C | - | -12 | V |
| | $+V_{OUT2}$ | $R_L = 2k\Omega$ | 4 | +25°C | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT2}$ | $R_L = 2k\Omega$ | 4 | +25°C | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 5 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -5 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = +5V$, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -PSRR | $\Delta V_{SUP} = -5V$, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT} = -5V$ to $+5V$ | 7 | +25°C | 0.9 | - | V/µs |
| | -SR | $V_{OUT} = +5V$ to $-5V$ | 7 | +25°C | 0.9 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT} = 0$ to $+200mV$, $10\% \le T_R \le 90\%$ | 7 | +25°C | - | 140 | ns |
| | $T_F$ | $V_{OUT} = 0$ to $-200mV$, $10\% \le T_F \le 90\%$ | 7 | +25°C | - | 140 | ns |
| Overshoot | +OS | $V_{OUT} = 0$ to $+200mV$ | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT} = 0$ to $-200mV$ | 7 | +25°C | - | 40 | % |
| Gain Bandwidth Product (Small Signal) | GBWP | $V_{OUT} = 50mV$ | 7 | +25°C | 2.5 | - | MHz |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 5kΩ, $C_{LOAD}$ = 50pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 260 | - | kΩ |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 14 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | 1 | - | V/V |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 350 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 180 | mW |
| Channel Separation | CS | f = 10kHz, $R_S$ = 1kΩ Referred to Input $A_V$ = 100V/V, $V_{IN}$ = 100m$V_{PEAK}$ | 1 | +25°C | -66 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
87 x 75 x 19 mils ± 1 mils
2210 x 1910 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 7kÅ ± 0.7kÅ

**WORST CASE CURRENT DENSITY:**
$1.68 \times 10^5$ A/cm$^2$

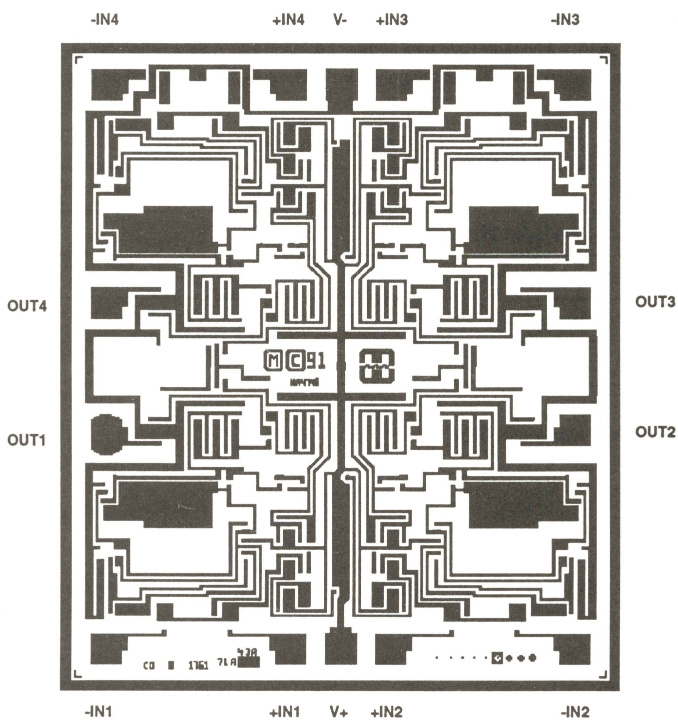
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 72

**PROCESS:** Junction Isolated Bipolar/JFET

## Metallization Mask Layout

HA-4741/883



HARRIS SEMICONDUCTOR

# HA-5002/883

## Monolithic, Wideband, High Slew Rate, High Output Current Buffer

July 1994



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Voltage Gain ($R_L$ = 1kΩ). . . . . . . . . . . . . . . . . . 0.98 (Min)**
  **0.995 (Typ)**
  **($R_L$ = 100Ω) . . . . . . . . . . . . . . . . 0.96 (Min)**
  **0.971 (Typ)**
- **High Input Impedance . . . . . . . . . . . . . . . . . 1.5MΩ (Min)**
  **3MΩ (Typ)**
- **Low Output Impedance . . . . . . . . . . . . . . . . . . 5Ω (Max)**
  **3Ω (Typ)**
- **Very High Slew Rate . . . . . . . . . . . . . . . 1000V/µs (Min)**
  **1300V/µs (Typ)**
- **Wide Small Signal Bandwidth. . . . . . . . . 110MHz (Typ)**
- **High Output Current . . . . . . . . . . . . . . . . . 100mA (Min)**
- **High Pulsed Output Current . . . . . . . . . . . 400mA (Max)**
- **Monolithic Dielectric Isolation Construction**
- **Replaces Hybrid LH0002**

### Applications

- **Line Driver**
- **Data Acquisition**
- **110MHz Buffer**
- **High Power Current Booster**
- **High Power Current Source**
- **Sample and Holds**
- **Radar Cable Driver**
- **Video Products**

### Description

The HA-5002/883 is a monolithic, wideband, high slew rate, high output current, buffer amplifier.

Utilizing the advantages of the Harris Dielectric Isolation technologies, the HA-5002/883 current buffer offers 1300V/µs slew rate typically and 1000V/µs minimum with 110MHz of bandwidth. The ±100mA minimum output current capability is enhanced by a 3Ω output impedance.

The monolithic HA-5002/883 will replace the hybrid LH0002 with corresponding performance increases. These characteristics range from the 3MΩ (typ) input impedance to the increased output voltage swing. Monolithic design technologies have allowed a more precise buffer to be developed with more than an order of magnitude smaller gain error. The voltage gain is 0.98 guaranteed minimum with a 1kΩ load and 0.96 minimum with a 100Ω load.

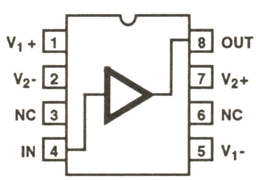
The HA-5002/883 will provide many present hybrid users with a higher degree of reliability and at the same time increase overall circuit performance.

### Ordering Information

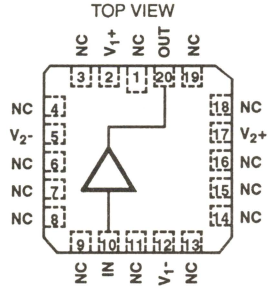
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5002/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5002/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5002/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

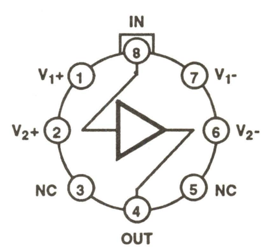
**HA-5002/883 (CERDIP)**
TOP VIEW




**HA-5002/883 (CLCC)**
TOP VIEW




**HA-5002/883 (METAL CAN)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511017-883**
File Number **3705**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 44V
Input Voltage ............................ Equal to Supplies
Peak Output Current (50ms On, 1s Off) ................. ±400mA
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating ...................................... <4000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Ceramic LCC Package ............................ 1.54W
Metal Can Package .............................. 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ................................ 8.7mW/°C
Ceramic LCC Package ........................ 15.4mW/°C
Metal Can Package ............................ 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ......................... ±12V to ±15V

$R_L \geq 100\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±12V and ±15V, $R_{SOURCE}$ = 50Ω, $C_{LOAD} \leq$ 10pF, $V_{IN}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO1}$ | $V_{SUP}$ = ±15V | 1 | +25°C | -20 | 20 | mV |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | mV |
| | $V_{IO2}$ | $V_{SUP}$ = ±12V | 1 | +25°C | -20 | 20 | mV |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | mV |
| Input Bias Current | $I_{B1}$ | $V_{SUP}$ = ±15V, $R_S$ = 1kΩ | 1 | +25°C | -7 | 7 | µA |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | µA |
| | $I_{B2}$ | $V_{SUP}$ = ±12V, $R_S$ = 1kΩ | 1 | +25°C | -7 | 7 | µA |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | µA |
| Voltage Gain 1 | $+AV_1$ | $V_{SUP}$ = ±12V, $R_L$ = 1kΩ, $V_{IN}$ = 10V | 1 | +25°C | 0.98 | - | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.98 | - | V/V |
| | $-AV_1$ | $V_{SUP}$ = ±12V, $R_L$ = 1kΩ, $V_{IN}$ = -10V | 1 | +25°C | 0.98 | - | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.98 | - | V/V |
| Voltage Gain 2 | $+AV_2$ | $V_{SUP}$ = ±12V, $R_L$ = 100Ω, $V_{IN}$ = 10V | 1 | +25°C | 0.96 | - | V/V |
| | $-AV_2$ | $V_{SUP}$ = ±12V, $R_L$ = 100Ω, $V_{IN}$ = -10V | 1 | +25°C | 0.96 | - | V/V |
| Voltage Gain 3 | $+AV_3$ | $V_{SUP}$ = ±15V, $R_L$ = 100Ω, $V_{IN}$ = 10V | 1 | +25°C | 0.96 | - | V/V |
| | $-AV_3$ | $V_{SUP}$ = ±15V, $R_L$ = 100Ω, $V_{IN}$ = -10V | 1 | +25°C | 0.96 | - | V/V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±12V and ±15V, $R_{SOURCE}$ = 50Ω, $C_{LOAD}$ ≤ 10pF, $V_{IN}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Voltage Gain 4 | $+AV_4$ | $V_{SUP}$ = ±15V, $R_L$ = 1kΩ, $V_{IN}$ = +10V | 1 | +25°C | 0.99 | - | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.99 | - | V/V |
| | $-AV_4$ | $V_{SUP}$ = ±15V, $R_L$ = 1kΩ, $V_{IN}$ = -10V | 1 | +25°C | 0.99 | - | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.99 | - | V/V |
| Output Voltage Swing | $+V_{OUT1}$ | $V_{SUP}$ = ±15V, $R_L$ = 100Ω, $V_{IN}$ = +15V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $V_{SUP}$ = ±15V, $R_L$ = 100Ω, $V_{IN}$ = -15V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $V_{SUP}$ = ±15V, $R_L$ = 1kΩ, $V_{IN}$ = +15V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT2}$ | $V_{SUP}$ = ±15V, $R_L$ = 1kΩ, $V_{IN}$ = -15V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT3}$ | $V_{SUP}$ = ±12V, $R_L$ = 1kΩ, $V_{IN}$ = +12V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT3}$ | $V_{SUP}$ = ±12V, $R_L$ = 1kΩ, $V_{IN}$ = -12V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT1}$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = +10V | 1 | +25°C | 100 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 100 | - | mA |
| | $-I_{OUT1}$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = -10V | 1 | +25°C | - | -100 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -100 | mA |
| | $+I_{OUT2}$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = +10V | 1 | +25°C | 100 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 100 | - | mA |
| | $-I_{OUT2}$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = -10V | 1 | +25°C | - | -100 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -100 | mA |
| Power Supply Rejection Ratio | $+PSRR_1$ | $\Delta V_{SUP}$ = ±5V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 54 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 54 | - | dB |
| | $-PSRR_1$ | $\Delta V_{SUP}$ = ±5V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 54 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 54 | - | dB |
| | $+PSRR_2$ | $\Delta V_{SUP}$ = ±5V, V+ = +17V, V- = -12V, V+ = +7V, V- = -12V | 1 | +25°C | 54 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 54 | - | dB |
| | $-PSRR_2$ | $\Delta V_{SUP}$ = ±5V, V+ = +12V, V- = -17V, V+ = +12V, V- = -7V | 1 | +25°C | 54 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 54 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±12V and ±15V, $R_{SOURCE}$ = 50Ω, $C_{LOAD}$ ≤ 10pF, $V_{IN}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Power Supply Current | $+ICC_1$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = 0V | 1 | +25°C | - | 10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA |
| | $-ICC_1$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = 0V | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |
| | $+ICC_2$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = 0V | 1 | +25°C | - | 10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA |
| | $-ICC_2$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = 0V | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V or ±12V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤ 10pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Input Resistance | $R_{IN1}$ | $V_{SUP}$ = ±15V | 1 | +25°C | 1.5 | - | MΩ |
| | $R_{IN2}$ | $V_{SUP}$ = ±12V | 1 | +25°C | 1.5 | - | MΩ |
| Slew Rate | $+SR_1$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = -5V to +5V | 1 | +25°C | 1000 | - | V/µs |
| | | | | +125°C, -55°C | 1000 | - | V/µs |
| | $-SR_1$ | $V_{SUP}$ = ±15V, $V_{OUT}$ = +5V to -5V | 1 | +25°C | 1000 | - | V/µs |
| | | | | +125°C, -55°C | 1000 | - | V/µs |
| | $+SR_2$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = -5V to +5V | 1 | +25°C | 1000 | - | V/µs |
| | | | | +125°C, -55°C | 1000 | - | V/µs |
| | $-SR_2$ | $V_{SUP}$ = ±12V, $V_{OUT}$ = +5V to -5V | 1 | +25°C | 1000 | - | V/µs |
| | | | | +125°C, -55°C | 1000 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{SUP}$ = ±15V or ±12V, $V_{OUT}$ = 0 to +500mV | 1, 2 | +25°C | - | 10 | ns |
| | | | 1, 2 | +125°C, -55°C | - | 10 | ns |
| | $T_F$ | $V_{SUP}$ = ±15V or ±12V, $V_{OUT}$ = 0 to -500mV | 1, 2 | +25°C | - | 10 | ns |
| | | | 1, 2 | +125°C, -55°C | - | 10 | ns |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±15V or ±12V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ ≤ 10pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Overshoot | +OS | $V_{SUP}$ = ±12V or ±15V, $V_{OUT}$ = 0 to +500mV | 1 | +25°C | - | 30 | % |
| | | | | +125°C, -55°C | - | 30 | % |
| | -OS | $V_{SUP}$ = ±12V or ±15V, $V_{OUT}$ = 0 to -500mV | 1 | +25°C | - | 30 | % |
| | | | | +125°C, -55°C | - | 30 | % |
| Quiescent Power Consumption | $PC_1$ | $V_{SUP}$ = ±15V, $V_{IN}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | +25°C | - | 300 | mW |
| | | | | +125°C, -55°C | - | 300 | mW |
| | $PC_2$ | $V_{SUP}$ = ±12V, $V_{IN}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | +25°C | - | 240 | mW |
| | | | | +125°C, -55°C | - | 240 | mW |
| Output Resistance | $R_{OUT1}$ | $V_{SUP}$ = ±12V | 1 | +25°C | - | 5 | Ω |
| | $R_{OUT2}$ | $V_{SUP}$ = ±12V | 1 | +25°C | - | 5 | Ω |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Measured between 10% and 90% points.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
81 x 80 x 19 mils ± 1 mils
2050 x 2030 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 20kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 7kÅ ± 0.7kÅ

**WORST CASE CURRENT DENSITY:**
$0.7 \times 10^5$ A/cm$^2$ at 3.6mA

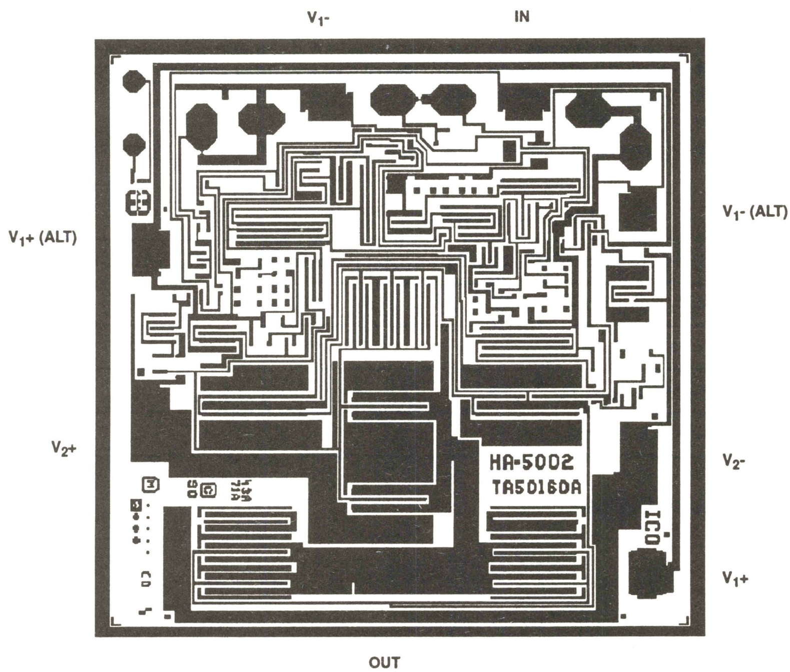
**SUBSTRATE POTENTIAL (Powered Up):** V1-

**TRANSISTOR COUNT:** 27

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5002/883



HARRIS SEMICONDUCTOR

# HA-5004/883

July 1994

## 100MHz Current Feedback Amplifier



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Slew Rate . . . . . . . . . . . . . . . . . . . . . . 1000V/μs (Min) 1200V/μs (Typ)**
- **Output Current . . . . . . . . . . . . . . . . . . . ±80mA (Min) ±100mA (Typ)**
- **Drives . . . . . . . . . . . . . . . . . . . ±8.0V into 100Ω (Min) ±9.5V into 100Ω (Typ)**
- **$V_{SUPPLY}$ . . . . . . . . . . . . . . . . . . . . . . . . ±5V to ±18V**
- **Thermal Overload Protection and Output Flag**
- **Bandwidth Nearly Independent of Gain**
- **Output Enable/Disable**

### Applications

- **Unity Gain Video/Wideband Buffer**
- **Video Gain Block**
- **High Speed Peak Detector**
- **Fiber Optic Transmitters**
- **Zero Insertion Loss Transmission Line Drivers**
- **Current to Voltage Converter**
- **Radar Systems**

### Description

The HA-5004/883 current feedback amplifier is a video/wideband amplifier optimized for low gain applications. The design is based on current-mode feedback which allows the amplifier to achieve higher closed loop bandwidth than voltage-mode feedback operational amplifiers. Since feedback is employed, the HA-5004/883 can offer better gain accuracy and lower distortion than open loop buffers. Unlike conventional op amps, the bandwidth and rise time of the HA-5004/883 are nearly independent of closed loop gain. The 100MHz bandwidth at unity gain reduces to only 65MHz at a gain of 10. The HA-5004/883 may be used in place of a conventional op amp with a significant improvement in speed power product.

Several features have been designed in for added value. A thermal overload feature protects the part against excessive junction temperature by shutting down the output. If this feature is not needed, it can be inhibited via a TTL input (TOI). A TTL chip enable/disable ($\overline{OE}$) input is also provided; when the chip is disabled its output is high impedance. Finally, an open collector output flag ($\overline{TOL}$) is provided to indicate the status of the chip. The status flag goes low to indicate when the chip is disabled due to either the internal Thermal Overload shutdown or the external disable.

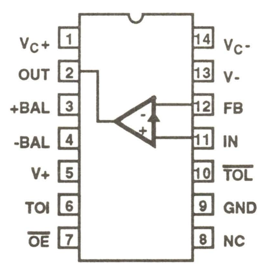
In order to maximize bandwidth and output drive capacity, internal current limiting is not provided. However, current limiting may be applied via the $V_C$+ and $V_C$- pins which provide power separately to the output stage.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5004/883 | -55°C to +125°C | 14 Lead CerDIP |

### Pinouts

**HA-5004/883**
**(CERDIP)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511053-883**
File Number **3706**

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals . . . . . . . . . . 40V
Differential Input Voltage. . . . . . . . . . . . . . . . 5V
Voltage at Either Input Terminal . . . . . . . . . . . V+ to V-
Peak Output Current Pulsed at 1ms ≤ 10% Duty Cycle. . . . . ±300mA
Continuous Output Current. . . . . . . . . . . . ±120mA rms
Junction Temperature ($T_J$) . . . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . -65°C to +150°C
ESD Rating. . . . . . . . . . . . . . . . . . . <2000V
Lead Temperature (Soldering 10s). . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package . . . . . . . . . . | 73°C/W | 18°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . 1.37W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . . . . . . . . . . . 13.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range. . . . . . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . . . . . . . . ±12V to ±15V
$R_L \geq 100\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V+ = $V_C$+ = +15V, V- = $V_C$- = -15V, $R_L$ = 100Ω, $A_V$ = +1, $R_F$ = 250Ω, $\overline{OE}$ = 0.8V, TOI = 0.8V or 2.0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{IN}$ = 0V | 1 | +25°C | -2.5 | 2.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Input Bias Current | $+I_B$ | $V_{IN}$ = 0V (Note 1) | 1 | +25°C | -5 | 5 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| DC Gain Error (Small Signal) | SSGE | $V_{IN}$ = ±100mV, $R_L$ = 100Ω | 1 | +25°C | - | 0.43 | % |
| | | | 2, 3 | +125°C, -55°C | - | 0.75 | % |
| DC Gain Error (Large Signal) | $LSGE_1$ | $V_{IN}$ = ±5.0V, $R_L$ = 1kΩ | 1 | +25°C | - | 0.43 | % |
| | | | 2, 3 | +125°C, -55°C | - | 0.75 | % |
| | $LSGE_2$ | $V_{IN}$ = ±10V, $R_L$ = 1kΩ | 1 | +25°C | - | 0.43 | % |
| | | | 2, 3 | +125°C, -55°C | - | 0.75 | % |
| DC Voltage Gain | $A_V$ | For All Gain Error Conditions (Note 2) | 1 | +25°C | 233 | - | V/V |
| | | | 2, 3 | +125°C, -55°C | 133 | - | V/V |
| DC Transimpedence | $A_R$ | For All Gain Error Conditions (Note 3) | 1 | +25°C | 58 | - | V/mA |
| | | | 2, 3 | +125°C, -55°C | 33 | - | V/mA |
| Output Voltage Swing | $\pm V_{OUT1}$ | $V_{IN}$ = ±15V, $R_L$ = 1kΩ | 1 | +25°C | 11.5 | -11.5 | V |
| | | | 2, 3 | +125°C, -55°C | 10.5 | -10.5 | V |
| | $\pm V_{OUT2}$ | $V_{IN}$ = ±10V, $R_L$ = 100Ω | 1 | +25°C | 9.0 | -9.0 | V |
| | | | 2, 3 | +125°C, -55°C | 8.0 | -8.0 | V |
| Output Current | $\pm I_{OUT}$ | $V_{IN}$ = ±10V, $R_L$ = 100Ω | 1 | +25°C | 90 | -90 | mA |
| | | | 2, 3 | +125°C, -55°C | 80 | -80 | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V+ = V_C+ = +15V$, $V- = V_C- = -15V$, $R_L = 100\Omega$, $A_V = +1$, $R_F = 250\Omega$, $\overline{OE} = 0.8V$, TOI = 0.8V or 2.0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Logic Input Voltage | $V_{IH}$ | Pins $\overline{OE}$, TOI (Note 4) | 1 | +25°C | 2.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.0 | - | V |
| | $V_{IL}$ | Pins $\overline{OE}$, TOI | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| Power Supply Rejection Ratio | $PSRR_1$ | V+ = +10V, +20V<br>V- = -15V | 1 | +25°C | 50 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 50 | - | dB |
| | $PSRR_2$ | V- = -10V, -20V<br>V+ = +15V | 1 | +25°C | 50 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 50 | - | dB |
| Power Supply Current | $+I_{CC}$ | $V_{IN} = 0V$, $R_L = 1k\Omega$ | 1 | +25°C | - | 16 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 22 | mA |
| | $-I_{CC}$ | $V_{IN} = 0V$, $R_L = 1k\Omega$ | 1 | +25°C | -16 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -22 | - | mA |

NOTES:

1. Inverting (FB) input is a low impedance point; Bias Current and Offset Current are not specified for this terminal.
2. DC Voltage Gain = $\frac{1}{\text{Gain Error}}$ , for all Gain Error conditions.
3. DC Transimpedance = $\frac{R_F}{\text{Gain Error}}$ , $R_F = 250\Omega$, for all Gain Error conditions.
4. Please refer to the Truth Table in the Applications Information section.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: V+ = $V_C$+ = +15V, V- = $V_C$- = -15V, $R_L$ = 1kΩ, $A_V$ = +1, $R_F$ = 250Ω, $C_L \leq$ 10pF, $\overline{OE}$ = 0.8V, TOI = 0.8V or 2.0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = 0V to +10V | 1, 2 | +25°C | 1000 | - | V/µs |
| | -SR | $V_{OUT}$ = 0V to -10V | 1, 2 | +25°C | 1000 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0V to +200mV, | 1, 2 | +25°C | - | 7.0 | ns |
| | $T_F$ | $V_{OUT}$ = 0V to -200mV | 1, 2 | +25°C | - | 7.0 | ns |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 2V | 1, 3 | +25°C | 79.5 | - | MHz |
| Quiescent Power Consumption | PC | $V_{IN}$ = 0V | 1, 4 | -55°C to +125°C | - | 660 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Measured between 10% and 90% points.
3. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
4. Power Consumption based upon Quiescent Supply Current test maximum.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
63 x 93 x 19 mils ± 1 mils
1600 x 2370 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over (Silox, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$6.6 \times 10^4 A/cm^2$

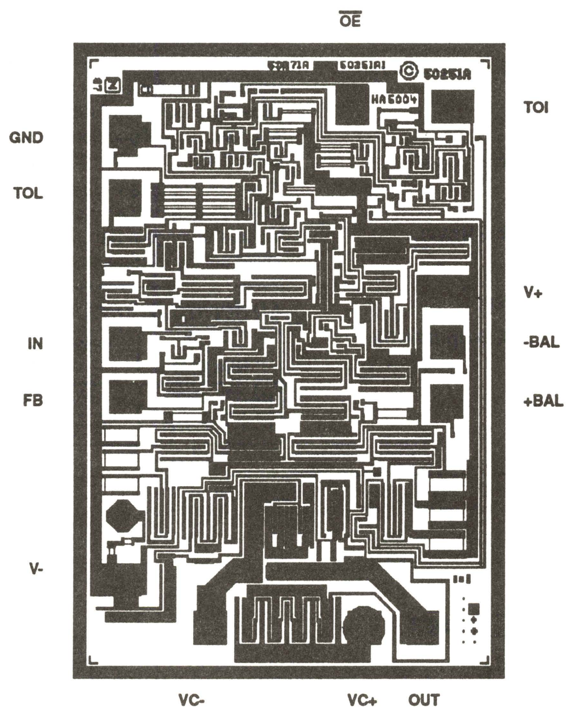
**SUBSTRATE POTENTIAL (Powered Up):** $V_{EE}$

**TRANSISTOR COUNT:** 64

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5004/883



HARRIS SEMICONDUCTOR

# HA-5020/883

## 100MHz Current Feedback Video Amplifier with Disable

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Wide Unity Gain Bandwidth .......... 105MHz (Min)
- Slew Rate .............................. 800V/µs
- Output Current ...................... ±30mA (Min)
- Drives 3.5V into 75Ω
- Differential Gain .......................... 0.025%
- Differential Phase ...................... 0.025 Deg
- Low Input Noise Voltage ................ 4.5nV/√Hz
- Low Supply Current .................... 10mA (Max)
- Wide Supply Range .................... ±5V to ±15V
- Output Enable/Disable
- High Performance Replacement for EL2020/883

### Applications

- Unity Gain Video/Wideband Buffer
- Video Gain Block
- Video Distribution Amp/Coax Cable Driver
- Flash A/D Driver
- Waveform Generator Output Driver
- Current to Voltage Converter; D/A Output Buffer
- Radar Systems
- Imaging Systems

### Description

The HA-5020/883 is a wide bandwidth, high slew rate amplifier optimized for video applications and gains between 1 and 10. Manufactured on Harris' Reduced Feature Complementary Bipolar DI process, this amplifier uses current mode feedback to maintain higher bandwidth at a given gain than conventional voltage feedback amplifiers. Since it is a closed loop device, the HA-5020/883 offers better gain accuracy and lower distortion than open loop buffers.

The HA-5020/883 features low differential gain and phase and will drive two double terminated 75Ω coax cables to video levels with low distortion. Adding a gain flatness performance of 0.1dB makes this amplifier ideal for demanding video applications. The bandwidth and slew rate of the HA-5020/883 are relatively independent of closed loop gain. The 105MHz unity gain bandwidth only decreases to 77MHz at a gain of 10. The HA-5020/883 used in place of a conventional op amp will yield a significant improvement in the speed power product. To further reduce power, the HA-5020/883 has a disable function which significantly reduces supply current, while forcing the output to a true high impedance state. This allows the outputs of multiple amplifiers to be wire-OR'd into multiplexer configurations. The device also includes output short circuit protection and output offset voltage adjustment.

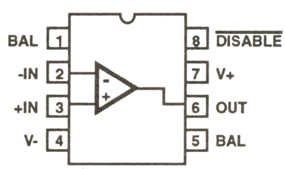
The HA-5020/883 offers significant enhancements over competing amplifiers, such as the EL2020. Improvements include unity gain bandwidth, slew rate, video performance, lower supply current, and superior DC specifications.

### Ordering Information

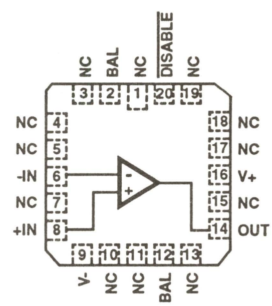
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA7-5020/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA4-5020/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HA-5020/883 (CERDIP) TOP VIEW




HA-5020/883 (CLCC) TOP VIEW



### Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 36V
Differential Input Voltage................................ 8V
Voltage at Either Input Terminal ..................... V+ to V-
Peak Output Current................ Full Short Circuit Protected
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating.....................................< 2000V
Lead Temperature (Soldering 10s)................... +300°C

### Thermal Information

Thermal Package Characteristics $\theta_{JA}$ $\theta_{JC}$
- CerDIP Package ...................... 115°C/W 30°C/W
- Ceramic LCC Package .................. 75°C/W 23°C/W

Package Power Dissipation Limit at +75°C for $T_J \le$ +175°C
- CerDIP Package ................................ 0.87W
- Ceramic LCC Package ............................ 1.33W

Package Power Dissipation Derating Factor Above +75°C
- CerDIP Package .............................. 8.7mW/°C
- Ceramic LCC Package ......................... 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage......................... ±5V to ±15V
$V_{INCM} \le 1/2(V+ - V-)$
$R_L \ge 400\Omega$
$R_F = 1k\Omega$
$V_{\overline{DISABLE}}$ = V+ or 0V

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage = ±15V, $R_{SOURCE} = 0\Omega$, $A_{VCL} = +1$, $R_F = 1k\Omega$, $R_{LOAD} = 400\Omega$, $V_{OUT} = 0V$, $V_{\overline{DISABLE}}$ = V+, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -8 | 8 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = 5V, V- = -25V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 50 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = 25V, V- = -5V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 50 | - | dB |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 13.5V, V+ = 4.5V, V- = -15V; V+ = 18V, V- = -15V | 1 | +25°C | 64 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 60 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 13.5V, V+ = 15V, V- = -4.5V; V+ = 15V, V- = -18V | 1 | +25°C | 64 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 60 | - | dB |
| Non-Inverting (+IN) Current | $I_{BP}$ | $V_{CM}$ = 0V | 1 | +25°C | -8 | 8 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| +IN Common Mode Rejection | IBPCMP | $\Delta V_{CM}$ = +10V, V+ = 5V, V- = -25V | 1 | +25°C | - | 0.1 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | µA/V |
| | IBPCMN | $\Delta V_{CM}$ = -10V, V+ = 25V, V- = -5V | 1 | +25°C | - | 0.1 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | µA/V |
| Non-Inverting (+IN) Input Impedance | $+R_{IN}$ | Calculated 1/IBPCMP | 1 | +25°C | 10 | - | MΩ |
| | | | 2, 3 | +125°C, -55°C | 2 | - | MΩ |
| +IN Power Supply Rejection | IBPPSP | $\Delta V_{SUP}$ = 13.5V, V+ = 4.5V, V- = -15V; V+ = 18V, V- = -15V | 1 | +25°C | - | 0.06 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.2 | µA/V |
| | IBPPSN | $\Delta V_{SUP}$ = 13.5V, V+ = 15V, V- = -4.5V; V+ = 15V, V- = -18V | 1 | +25°C | - | 0.06 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.2 | µA/V |
| Inverting Input (-IN) Current | $I_{BN}$ | $V_{CM}$ = 0V | 1 | +25°C | -20 | 20 | µA |
| | | | 2, 3 | +125°C, -55°C | -50 | 50 | µA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: Supply Voltage = ±15V, $R_{SOURCE}$ = 0Ω, $A_{VCL}$ = +1, $R_F$ = 1kΩ, $R_{LOAD}$ = 400Ω, $V_{OUT}$ = 0V, $V_{\overline{DISABLE}}$ = V+, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -IN Common Mode Rejection | IBNCMP | $\Delta V_{CM}$ = +10V, V+ = 5V, V- = -25V | 1 | +25°C | - | 0.4 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | μA/V |
| | IBNCMN | $\Delta V_{CM}$ = -10V, V+ = 25V, V- = -5V | 1 | +25°C | - | 0.4 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | μA/V |
| -IN Power Supply Rejection | IBNPSP | $\Delta V_{SUP}$ = 13.5V, V+ = 4.5V, V- = -15V; V+ = 18V, V- = -15V | 1 | +25°C | - | 0.2 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | μA/V |
| | IBNPSN | $\Delta V_{SUP}$ = 13.5V, V+ = 15V, V- = -4.5V; V+ = 15V, V- = -18V | 1 | +25°C | - | 0.2 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | μA/V |
| Common Mode Range | +CMR | V+ = 5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = 25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Transimpedance | $+A_{ZOL1}$ | $R_L$ = 400Ω, $V_{OUT}$ = 0 to 10V | 1 | +25°C | 1 | - | MΩ |
| | | | 2, 3 | +125°C, -55°C | 1 | - | MΩ |
| | $-A_{ZOL1}$ | $R_L$ = 400Ω, $V_{OUT}$ = 0 to -10V | 1 | +25°C | 1 | - | MΩ |
| | | | 2, 3 | +125°C, -55°C | 1 | - | MΩ |
| Output Voltage Swing | $+V_{OUT}$ | $V_{IN}$ = 12.8V | 1, 2 | +25°C, +125°C | 12 | - | V |
| | | | 3 | -55°C | 11 | - | V |
| | $-V_{OUT}$ | $V_{IN}$ = -12.8V | 1, 2 | +25°C, +125°C | - | -12 | V |
| | | | 3 | -55°C | - | -11 | V |
| | $+V_{OUT5}$ | V+ = 5V, V- = -5V, $V_{IN}$ = 3V | 1 | +25°C | 2 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2 | - | V |
| | $-V_{OUT5}$ | V+ = 5V, V- = -5V, $V_{IN}$ = -3V | 1 | +25°C | - | -2 | V |
| | | | 2, 3 | +125°C, -55°C | - | -2 | V |
| Output Current | $+I_{OUT}$ | Note 1 | 1, 2 | +25°C, +125°C | 30 | - | mA |
| | | | 3 | -55°C | 27.5 | - | mA |
| | $-I_{OUT}$ | Note 1 | 1, 2 | +25°C, +125°C | - | -30 | mA |
| | | | 3 | -55°C | - | -27.5 | mA |
| Short Circuit Output Current | $+I_{SC}$ | $R_L$ = Open, $V_{IN}$ = 10V | 1 | +25°C | 50 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 50 | - | mA |
| | $-I_{SC}$ | $R_L$ = Open, $V_{IN}$ = -10V | 1 | +25°C | - | -50 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -50 | mA |
| Disabled Output Current | $+I_{LEAK}$ | $V_{IN}$ = 0V, $V_{OUT}$ = +10V, $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | -1 | 1 | μA |
| | | | 3 | -55°C | -1 | 1 | μA |
| | | $V_{IN}$ = 2V | 2 | +125°C | -1 | 1 | μA |
| | $-I_{LEAK}$ | $V_{IN}$ = 0V, $V_{OUT}$ = -10V, $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | -1 | 1 | μA |
| | | | 3 | -55°C | -1 | 1 | μA |
| | | $V_{IN}$ = -2V | 2 | +125°C | -1 | 1 | μA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: Supply Voltage = ±15V, $R_{SOURCE}$ = 0Ω, $A_{VCL}$ = +1, $R_F$ = 1kΩ, $R_{LOAD}$ = 400Ω, $V_{OUT}$ = 0V, $V_{\overline{DISABLE}}$ = V+, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Disable Pin Input Current | $I_{LOGIC}$ | $V_{\overline{DIS}}$ = 0V | 1, 2 | +25°C, +125°C | -1 | 0 | mA |
| | | | 3 | -55°C | -1.5 | 0 | mA |
| Minimum $\overline{DISABLE}$ Pin Current to Disable | $I_{DIS}$ | Note 2 | 1 | +25°C | - | 350 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 350 | µA |
| Maximum $\overline{DISABLE}$ Pin Current to Enable | $I_{EN}$ | Note 3 | 1 | +25°C | 20 | - | µA |
| | | | 2, 3 | +125°C, -55°C | 20 | - | µA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L$ = Open | 1 | +25°C | - | 10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA |
| | $I_{EE}$ | $R_L$ = Open | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |
| Disabled Power Supply Current | $I_{CCDIS}$ | $R_L$ = 400Ω, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | - | 5.6 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7.5 | mA |
| | $I_{EEDIS}$ | $R_L$ = 400Ω, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | -5.6 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7.5 | - | mA |
| Offset Voltage Adjustment | $+V_{ADJ}$ | Note 4 | 1 | +25°C | 30 | - | mV |
| | | | 2, 3 | +125°C, -55°C | 25 | - | mV |
| | $-V_{ADJ}$ | Note 4 | 1 | +25°C | - | -30 | mV |
| | | | 2, 3 | +125°C, -55°C | - | -25 | mV |

NOTES:

1. Guaranteed from $V_{OUT}$ test by $I_{OUT} = V_{OUT}/400Ω$.
2. This is the minimum current which must be sourced from the $\overline{DISABLE}$ pin, to disable the output. The output is considered disabled when $V_{OUT} \leq$ 10mV. Conditions are: $V_{IN}$ = 10V, $R_L$ = 100Ω. The test is performed by sourcing 350µA from the $\overline{DISABLE}$ pin, and testing that the output decreases below the test limit (10mV).
3. This is the maximum current that can be sourced from the $\overline{DISABLE}$ pin with the device remaining enabled. The device is considered disabled when the supply current decreases by at least 0.5mA. Conditions are: $R_L$ = 400Ω. Test is performed by sourcing 20µA from the $\overline{DISABLE}$ pin, and testing that the supply current decreases by no more than the test limit (0.5mA).
4. The offset adjustment range is referred to the output. The inverting input current ($-I_{BIAS}$) can be adjusted with an external pot between pins 1 and 5, wiper connected to V+. Since $-I_{BIAS}$ flows through $R_F$, an adjustment of offset voltage results. The amount of offset adjustment is proportional to the value of $R_F$. Test conditions are: $R_L$ = Open, 10kΩ from pin 5 to V+, 1kΩ from pin 1 to V+, for $+V_{ADJ}$; $R_L$ = Open, 1kΩ from pin 5 to V+, 10kΩ from pin 1 to V+, for $-V_{ADJ}$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 400Ω, $C_{LOAD} \leq$ 10pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{IN}$ = -10V to +10V | 4 | +25°C | 600 | - | V/µs |
| | | | 5, 6 | +125°C, -55°C | 400 | - | V/µs |
| | -SR | $V_{IN}$ = +10V to -10V | 4 | +25°C | 600 | - | V/µs |
| | | | 5, 6 | +125°C, -55°C | 400 | - | V/µs |

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: Supply Voltage = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 400Ω, $R_F$ = 1kΩ, $V_{\overline{DISABLE}}$ = V+, $C_{LOAD}$ ≤ 10pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | $BW_1$ | $V_O$ = 100mV$_{RMS}$, $A_V$ = +1 | 1 | +25°C | 105 | - | MHz |
| | $BW_{10}$ | $V_O$ = 100mV$_{RMS}$, $A_V$ = +10, $R_F$ = 360Ω, $R_L$ = Open | 1 | +25°C | 77 | - | MHz |
| Gain Flatness | $GF_5$ | $V_O$ = 100mV$_{RMS}$, f = 5MHz | 1 | +25°C | -0.075 | +0.075 | dB |
| | $GF_{10}$ | $V_O$ = 100mV$_{RMS}$, f = 10MHz | 1 | +25°C | -0.2 | +0.2 | dB |
| Rise Time | $t_R$ | $V_O$ = 0V to 1V, $R_L$ = 100Ω | 1, 2 | +25°C | - | 3.7 | ns |
| Fall Time | $t_F$ | $V_O$ = 1V to 0V, $R_L$ = 100Ω | 1, 3 | +25°C | - | 4.0 | ns |
| Overshoot | +OVS | $V_O$ = 0V to 1V, $R_L$ = 100Ω | 1 | +25°C | - | 18.0 | % |
| | -OVS | $V_O$ = 1V to 0V, $R_L$ = 100Ω | 1 | +25°C | - | 16.6 | % |
| Slew Rate | $+SR_{10}$ | $V_O$ = -10V to 10V, $A_V$ = +10, $R_F$ = 360Ω, $R_L$ = Open | 1, 4 | +25°C | 1070 | - | V/µs |
| | $-SR_{10}$ | $V_O$ = 10V to -10V, $A_V$ = +10, $R_F$ = 360Ω, $R_L$ = Open | 1, 5 | +25°C | 860 | - | V/µs |
| Disable Time | $+t_{DIS}$ | $V_O$ = 2V to 0V, 50% of $V_{\overline{DIS}}$ to 90% $V_O$ | 1, 6 | +25°C | - | 3.13 | µs |
| | $-t_{DIS}$ | $V_O$ = -2V to 0V, 50% of $V_{\overline{DIS}}$ to 90% $V_O$ | 1, 6 | +25°C | - | 2.44 | µs |
| Enable Time | $+t_{EN}$ | $V_O$ = 0V to 2V, 50% to 90% | 1, 7 | +25°C | - | 1.45 | µs |
| | $-t_{EN}$ | $V_O$ = 0V to -2V, 50% to 90% | 1, 7 | +25°C | - | 1.49 | µs |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Measured from 10% to 90% of the output waveform.
3. Measured from 90% to 10% of the output waveform.
4. Measured from 25% to 75% of the output waveform.
5. Measured from 75% to 25% of the output waveform.
6. $\overline{DISABLE}$ = +15V to 0V. Measured from the 50% of $\overline{DISABLE}$ to $V_{OUT}$ = ±200mV.
7. $\overline{DISABLE}$ = 0V to +15V. Measured from the 50% of $\overline{DISABLE}$ to $V_{OUT}$ = ±1.8V.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
65 x 60 x 19 mils ± 1 mils
1640μm x 1520μm x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**WORST CASE CURRENT DENSITY:**
$5.77 \times 10^4$ A/$cm^2$ at 30mA

**SUBSTRATE POTENTIAL (Powered Up):** V-

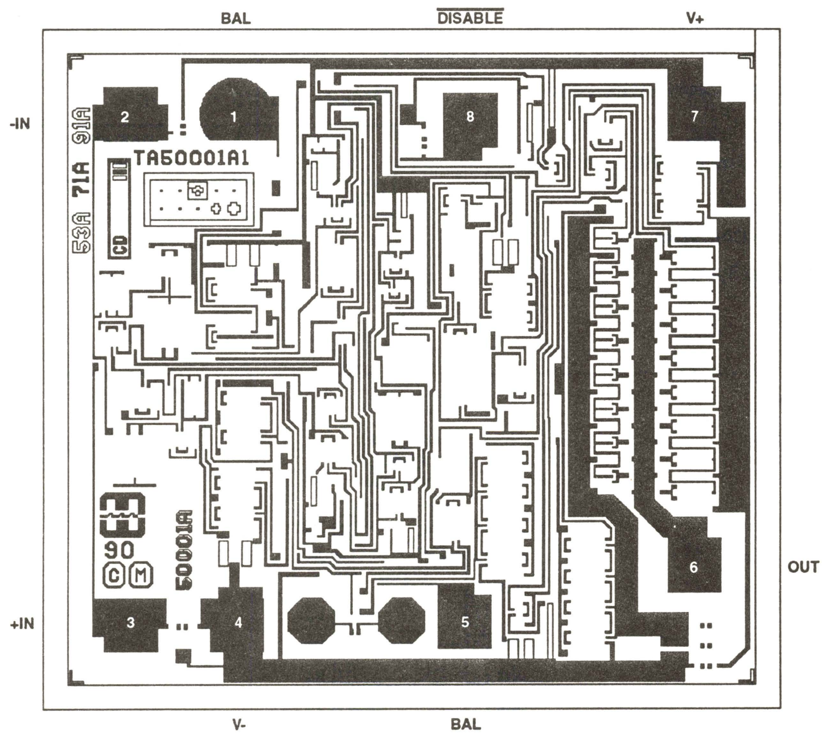
**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1kÅ

**TRANSISTOR COUNT:** 62

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5020/883



HARRIS SEMICONDUCTOR

# HA5022/883

## ADVANCE INFORMATION

July 1994

## Dual 100MHz Video Current Feedback Amplifier with Disable

### Features

- **This Circuit Is Processed In Accordance to MIL-STD-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Dual Version of HA-5020**
- **Individual Output Enable/Disable**
- **Wide Unity Gain Bandwidth . . . . . . . . . . . . . . . 125MHz**
- **Slew Rate . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 475V/μs**
- **Differential Gain . . . . . . . . . . . . . . . . . . . . . . . . . 0.03%**
- **Differential Phase. . . . . . . . . . . . . . . . . . . . . . . 0.03 Deg.**
- **Supply Current (per Amplifier) . . . . . . . . . . . . . . 7.5mA**
- **Crosstalk Rejection at 10MHz. . . . . . . . . . . . . . . . -60dB**
- **ESD Protection. . . . . . . . . . . . . . . . . . . . . . . . . . . 2000V**
- **Guaranteed Specifications at ±5V Supplies**

### Applications

- **Video Multiplexers; Video Switching and Routing**
- **Video Gain Block**
- **Video Distribution Amplifier/RGB Amplifier**
- **Flash A/D Driver**
- **Current to Voltage Converter**
- **Radar and Imaging Systems**
- **Medical Imaging**

### Description

The HA5022/883 is a dual version of the popular Harris HA-5020. It features wide bandwidth and high slew rate, and is optimized for video applications and gains between 1 and 10. It is a current feedback amplifier and thus yields less bandwidth degradation at high closed loop gains than voltage feedback amplifiers.

The low differential gain and phase, 0.1dB gain flatness, and ability to drive two back terminated 75Ω cables, make this amplifier ideal for demanding video applications.

The HA5022/883 also features a disable function that significantly reduces supply current while forcing the output to a true high impedance state. This functionality allows 2:1 video multiplexers to be implemented with a single IC.

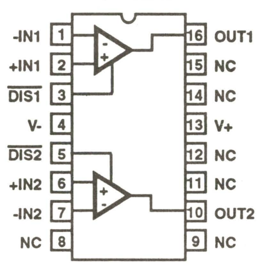
The current feedback design allows the user to take advantage of the amplifier's bandwidth dependency on the feedback resistor. By reducing $R_F$, the bandwidth can be increased to compensate for decreases at higher closed loop gains or heavy output loads.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA5022MJ/883 | -55°C to +125°C | 16 Lead CerDIP |

### Pinout

HA5022/883
(CERDIP)
TOP VIEW








Spec Number **511107-883**
File Number **3729**

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . . . . . . . . . . . . . . 36V
Differential Input Voltage. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10V
Voltage at Either Input Terminal . . . . . . . . . . . . . . . . . . . . . . V+ to V-
Output Current . . . . . . . . . . . . . . . . . . . . Full Short Circuit Protected
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . < 2000V
Storage Temperature Range . . . . . . . . . . . . . . $-65°C \leq T_A \leq +150°C$
Lead Temperature (Soldering 10s) . . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package . . . . . . . . . . . . . . . . . | 75°C/W | 20°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$). . . . . . . . . . . . . . . . . . . . $\pm5V$ to $\pm15V$ — $V_{INCM} \leq 1/2(V+ - V-)$ — $R_L \geq 50\Omega$
Operating Temperature Range. . . . . . . . . . . . . $-55°C \leq T_A \leq +125°C$ — $V_{\overline{DISABLE}}$ = V+ or 0V — $R_F = 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 1k\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 400\Omega$, $V_{OUT} = 0V$, $V_{\overline{DISABLE}}$ = V+, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -3 | 3 | mV |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm2.5V$<br>V+ = 2.5V, V- = -7.5V<br>V+ = 7.5V, V- = -2.5V | 1 | +25°C | 53 | - | dB |
| | | | 2 | +125°C | 38 | - | dB |
| | | $\Delta V_{CM} = \pm2.25V$<br>V+ = 2.75V, V- = -7.25V<br>V+ = 7.25V, V- = -2.75V | 3 | -55°C | 38 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP} = \pm1.5V$<br>V+ = 6.5V, V- = -5V<br>V+ = 3.5V, V- = -5V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 55 | - | dB |
| Delta Input Offset Voltage Between Channels | $\Delta V_{IO}$ | $V_{CM}$ = 0 | 1 | +25°C | - | 2 | mV |
| | | | 2,3 | +125°C, -55°C | - | 3.5 | mV |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -8 | 8 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM} = \pm2.5V$<br>V+ = 2.5V, V- = -7.5V<br>V+ = 7.5V, V- = -2.5V | 1 | +25°C | - | 0.15 | µA/V |
| | | | 2 | +125°C | - | 2.0 | µA/V |
| | | $\Delta V_{CM} = \pm2.25V$<br>V+ = 2.75V, V- = -7.25V<br>V+ = 7.25V, V- = -2.75V | 3 | -55°C | - | 2.0 | µA/V |
| ΔInverting Input (-IN) Current Between Channels | $\Delta I_{BSN}$ | $V_{CM}$ = 0 | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C | -30 | 30 | µA |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | 1 | +25°C | -12 | 12 | µA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | µA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 1k\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 400\Omega$, $V_{OUT} = 0V$, $V_{\overline{DISABLE}} = V+$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM} = \pm2.5V$, V+ = 2.5V, V- = -7.5V, V+ = 7.5V, V- = -2.5V | 1 | +25°C | - | 0.4 | µA/V |
| | | | 2 | +125°C | - | 5 | µA/V |
| | | $\Delta V_{CM} = \pm2.25V$, V+ = 2.75V, V- = -7.25V, V+ = 7.25V, V- = -2.75V | 3 | -55°C | - | 5 | µA/V |
| -IN Current Power Supply Sensitivity | $PSS_{IBN}$ | $\Delta V_{SUP} = \pm1.5V$, V+ = 6.5V, V- = -5V, V+ = 3.5V, V- = -5V | 1 | +25°C | - | 0.2 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | µA/V |
| +IN Current Power Supply Sensitivity | $PSS_{IBP}$ | $\Delta V_{SUP} = \pm1.5V$, V+ = 6.5V, V- = -5V, V+ = 3.5V, V- = -5V | 1 | +25°C | - | 0.1 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.3 | µA/V |
| Output Voltage Swing | $V_{OP}$ | $A_V = +1$, $R_L = 150\Omega$, $V_{IN} = -3V$ | 1 | +25°C | 2.5 | - | V |
| | | $V_{IN} = -3V$ | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON}$ | $A_V = +1$, $R_L = 150\Omega$, $V_{IN} = +3V$ | 1 | +25°C | - | -2.5 | V |
| | | $V_{IN} = +3V$ | 2, 3 | +125°C, -55°C | - | -2.5 | V |
| Short Circuit Output Current | $+I_{SC}$ | $V_{IN} = \pm2.5V$, $V_{OUT} = 0V$ | 1 | +25°C | 50 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 50 | - | mA |
| | $-I_{SC}$ | $V_{IN} = \pm2.5V$, $V_{OUT} = 0V$ | 1 | +25°C | - | -40 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -40 | mA |
| Output Current | $+I_{OUT}$ | Note 1 | 1 | +25°C | 20 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 16.6 | - | mA |
| | $-I_{OUT}$ | Note 1 | 1 | +25°C | - | -20 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -16.6 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 400\Omega$ | 1 | +25°C | - | 10 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA/Op Amp |
| | $I_{EE}$ | $R_L = 400\Omega$ | 1 | +25°C | -10 | - | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA/Op Amp |
| Transimpedance | $+A_{ZOL1}$ | $R_L = 400\Omega$, $V_{OUT} = \pm2.5V$ | 1 | +25°C | 1 | - | MΩ |
| | | | 2 | +125°C | 0.85 | - | MΩ |
| | | $V_{OUT} = \pm2.25V$ | 3 | -55°C | 0.85 | - | MΩ |
| | $-A_{ZOL1}$ | $R_L = 400\Omega$, $V_{OUT} = \pm2.5V$ | 1 | +25°C | 1 | - | MΩ |
| | | | 2 | +125°C | 0.85 | - | MΩ |
| | | $V_{OUT} = \pm2.25V$ | 3 | -55°C | 0.85 | - | MΩ |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 1kΩ, $R_{SOURCE}$ = 0Ω, $R_L$ = 400Ω, $V_{OUT}$ = 0V, $V_{\overline{DISABLE}}$ = V+, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Disabled Output Current | $+I_{LEAK}$ | $V_{IN}$ = 0V, $V_{OUT}$ = +2.5V $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | - | 1 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 2 | μA |
| | $-I_{LEAK}$ | $V_{IN}$ = 0V, $V_{OUT}$ = -2.5V $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | - | 1 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 2 | μA |
| Disable Pin Input Current | $I_{LOGIC}$ | $V_{\overline{DIS}}$ = 0V | 1 | +25°C | -1.0 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -1.5 | - | mA |
| Minimum $\overline{\text{DISABLE}}$ Pin Current to Disable | $I_{DIS}$ | Note 2 | 1 | +25°C | - | 350 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 350 | μA |
| Maximum $\overline{\text{DISABLE}}$ Pin Current to Enable | $I_{EN}$ | Note 3 | 1 | +25°C | 20 | - | μA |
| | | | 2, 3 | +125°C, -55°C | 20 | - | μA |
| Disabled Power Supply Current | $I_{CCDIS}$ | $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | - | 7.5 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | - | 7.5 | mA/Op Amp |
| | $I_{EEDIS}$ | $R_L$ = Open, $V_{\overline{DIS}}$ = 0V | 1 | +25°C | 7.5 | - | mA/Op Amp |

NOTE:

1. Guaranteed from $V_{OUT}$ Test with $R_L$ = 150Ω, by: $I_{OUT} = V_{OUT}/150Ω$.
2. $R_L$ = 100Ω, $V_{IN}$ = 2.5V. This is the minimum current which must be pulled out of the $\overline{\text{Disable}}$ pin in order to disable the output. The output is considered disabled when -10mV ≤ $V_{OUT}$ ≤ +10mV.
3. $V_{IN}$ = 0V. This is the maximum current that can be pulled out of the $\overline{\text{Disable}}$ pin with the HA5022/883 remaining enabled. The HA5022/883 is considered disabled when the supply current has decreased by at least 0.5mA.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
65 x 100 x 19 mils ± 1 mils
1650 x 2540 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Metal 1: AlCu (1%), Metal 2: AlCu (1%)
Thickness: Metal 1: 8kÅ ± 0.4kÅ, Metal 2: 16kÅ ± 0.8kÅ

**WORST CASE CURRENT DENSITY:**
$1.62 \times 10^5$ A/cm$^2$ at 35mA

**SUBSTRATE POTENTIAL (Powered Up):** V-

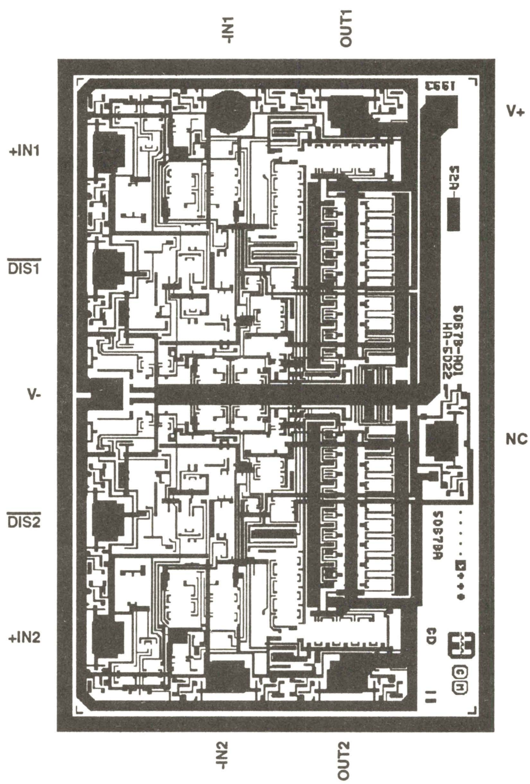
**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.4kÅ

**TRANSISTOR COUNT:** 124

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA5022/883



# HARRIS SEMICONDUCTOR

# HA5023/883

## ADVANCE INFORMATION

July 1994

## Dual 100MHz Video Current Feedback Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Wide Unity Gain Bandwidth ................ 125MHz
- Slew Rate ............................. 475V/µs
- Differential Gain .......................... 0.03%
- Differential Phase. ...................... 0.03 Deg.
- Supply Current (per Amplifier) .............. 7.5mA
- Crosstalk Rejection at 10MHz................ -60dB
- ESD Protection ........................... 2000V
- Guaranteed Specifications at ±5V Supplies

### Applications

- Video Gain Block
- Video Distribution Amplifier/RGB Amplifier
- Flash A/D Driver
- Current to Voltage Converter
- Radar and Imaging Systems
- Medical Imaging

### Description

The HA5023/883 is a dual version of the popular Harris HA-5020/883 except that it does not have an enable function. It features wide bandwidth and high slew rate, and is optimized for video applications and gains between 1 and 10. It is a current feedback amplifier and thus yields less bandwidth degradation at high closed loop gains than voltage feedback amplifiers.

The low differential gain and phase, 0.1dB gain flatness, and ability to drive two back terminated 75Ω cables, make this amplifier ideal for demanding video applications.

The current feedback design allows the user to take advantage of the amplifier's bandwidth dependency on the feedback resistor. By reducing $R_F$, the bandwidth can be increased to compensate for decreases at higher closed loop gains or heavy output loads.

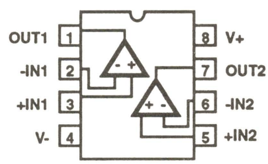
### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA5023MJ/883 | -55°C to +125°C | 8 Lead CerDIP |



### Pinout

HA5023/883
(CERDIP)
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . . . . . . . . . . . . . . 36V
Differential Input Voltage. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10V
Voltage at Either Input Terminal . . . . . . . . . . . . . . . . . . . . . V+ to V-
Output Current . . . . . . . . . . . . . . . . . . . Fully Short Circuit Protected
Junction Temperature. . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . < 2000V
Storage Temperature Range . . . . . . . . . . . . . . $-65°C \le T_A \le +150°C$
Lead Temperature (Soldering 10s). . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package . . . . . . . . . . . . . . . . . | 115°C/W | 28°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$). . . . . . . . . . . . . . . . . . . . . ±5V to ±15V
Operating Temperature Range. . . . . . . . . . . . . $-55°C \le T_A \le +125°C$

$V_{INCM} \le 1/2(V+ - V-)$
$R_L \ge 50\Omega$    $R_F = 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 1k\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 400\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -3 | 3 | mV |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm2.5V$<br>V+ = 2.5V, V- = -7.5V<br>V+ = 7.5V, V- = -2.5V | 1 | +25°C | 53 | - | dB |
| | | | 2 | +125°C | 38 | - | dB |
| | | $\Delta V_{CM} = \pm2.25V$<br>V+ = 2.75V, V- = -7.25V<br>V+ = 7.25V, V- = -2.75V | 3 | -55°C | 38 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP} = \pm1.5V$<br>V+ = 6.5V, V- = -5V<br>V+ = 3.5V, V- = -5V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 55 | - | dB |
| Delta Input Offset Voltage Between Channels | $\Delta V_{IO}$ | $V_{CM} = 0$ | 1 | +25°C | - | 2 | mV |
| | | | 2,3 | +125°C, -55°C | - | 3.5 | mV |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -8 | 8 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM} = \pm2.5V$<br>V+ = 2.5V, V- = -7.5V<br>V+ = 7.5V, V- = -2.5V | 1 | +25°C | - | 0.15 | µA/V |
| | | | 2 | +125°C | - | 2.0 | µA/V |
| | | $\Delta V_{CM} = \pm2.25V$<br>V+ = 2.75V, V- = -7.25V<br>V+ = 7.25V, V- = -2.75V | 3 | -55°C | - | 2.0 | µA/V |
| ΔInverting Input (-IN) Current Between Channels | $\Delta I_{BSN}$ | $V_{CM} = 0$ | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | µA |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM} = 0V$ | 1 | +25°C | -12 | 12 | µA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | µA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM} = \pm2.5V$<br>V+ = 2.5V, V- = -7.5V<br>V+ = 7.5V, V- = -2.5V | 1 | +25°C | - | 0.4 | µA/V |
| | | | 2 | +125°C | - | 5 | µA/V |
| | | $\Delta V_{CM} = \pm2.25V$<br>V+ = 2.75V, V- = -7.25V<br>V+ = 7.25V, V- = -2.75V | 3 | -55°C | - | 5 | µA/V |
| -IN Current Power Supply Sensitivity | $PSS_{IBN}$ | $\Delta V_{SUP} = \pm1.5V$<br>V+ = 6.5V, V- = -5V<br>V+ = 3.5V, V- = -5V | 1 | +25°C | - | 0.2 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.5 | µA/V |
| +IN Current Power Supply Sensitivity | $PSS_{IBP}$ | $\Delta V_{SUP} = \pm1.5V$<br>V+ = 6.5V, V- = -5V<br>V+ = 3.5V, V- = -5V | 1 | +25°C | - | 0.1 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 0.3 | µA/V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 1k\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 400\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $V_{OP}$ | $A_V = +1$, $V_{IN} = -3V$ | 1 | +25°C | 2.5 | - | V |
| | | $R_L = 150\ \Omega$, $V_{IN} = -3V$ | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON}$ | $A_V = +1$, $V_{IN} = +3V$ | 1 | +25°C | - | -2.5 | V |
| | | $R_L = 150\ \Omega$, $V_{IN} = +3V$ | 2, 3 | +125°C, -55°C | - | -2.5 | V |
| Short Circuit Output Current | $+I_{SC}$ | $V_{IN} = \pm2.5V$, $V_{OUT} = 0V$ | 1 | +25°C | 50 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 50 | - | mA |
| | $-I_{SC}$ | $V_{IN} = \pm2.5V$, $V_{OUT} = 0V$ | 1 | +25°C | - | -40 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -40 | mA |
| Output Current | $+I_{OUT}$ | Note 1 | 1 | +25°C | 20 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 16.6 | - | mA |
| | $-I_{OUT}$ | Note 1 | 1 | +25°C | - | -20 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -16.6 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 400\Omega$ | 1 | +25°C | - | 10 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | - | 10 | mA/Op Amp |
| | $I_{EE}$ | $R_L = 400\Omega$ | 1 | +25°C | -10 | - | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA/Op Amp |
| Transimpedance | $+A_{ZOL1}$ | $R_L = 400\Omega$, $V_{OUT} = \pm2.5V$ | 1 | +25°C | 1 | - | MΩ |
| | | | 2, 3 | +125°C | 0.85 | - | MΩ |
| | | $V_{OUT} = \pm2.25V$ | 3 | -55°C | 0.85 | - | MΩ |
| | $-A_{ZOL1}$ | $R_L = 400\Omega$, $V_{OUT} = \pm2.5V$ | 1 | +25°C | 1 | - | MΩ |
| | | | 2, 3 | +125°C | 0.85 | - | MΩ |
| | | $V_{OUT} = \pm2.25V$ | 3 | -55°C | 0.85 | - | MΩ |

NOTE:

1. Guaranteed from $V_{OUT}$ Test with $R_L = 150\Omega$, by: $I_{OUT} = V_{OUT}/150\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
65 x 100 x 19 mils ± 1 mils
1650 x 2540 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Metal 1: AlCu (1%), Metal 2: AlCu (1%)
Thickness: Metal 1: 8kÅ ± 0.4kÅ, Metal 2: 16kÅ ± 0.8kÅ

**WORST CASE CURRENT DENSITY:**
$1.9 \times 10^5$ A/cm$^2$ at 15mA

**SUBSTRATE POTENTIAL (Powered Up):** V-

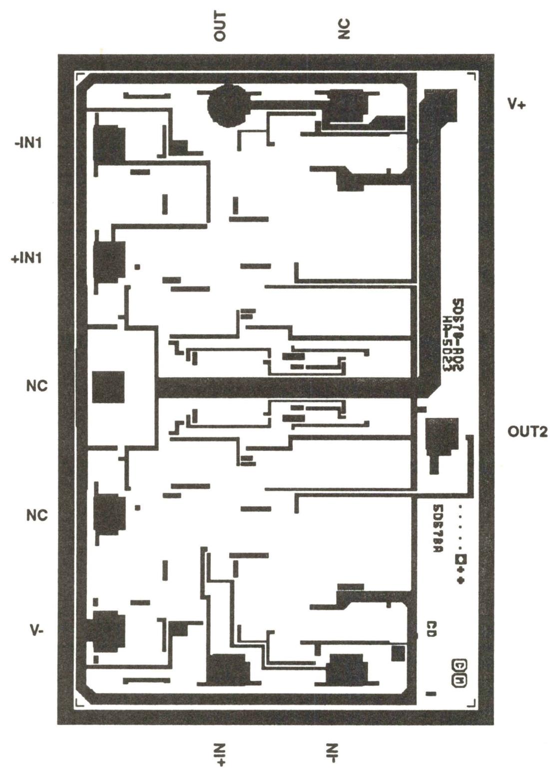
**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.4kÅ

**TRANSISTOR COUNT:** 124

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA5023/883



HARRIS SEMICONDUCTOR

# HA-5102/883

## Dual, Low Noise, High Performance Operational Amplifier

June 1994



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Input Noise Voltage Density at 1kHz . . 6nV/√Hz (Max) 4.3nV/√Hz (Typ)**
- **High Slew Rate . . . . . . . . . . . . . . . . . . . . . . . 1V/µs (Min) 3V/µs (Typ)**
- **Unity Gain Bandwidth . . . . . . . . . . . . . . . . . 8MHz (Typ)**
- **High Open Loop Gain (Full Temp) . . . . . 100kV/V (Min) 250kV/V (Typ)**
- **High CMRR, PSRR (Full Temp) . . . . . . . . . . . 86dB (Min) 100dB (Typ)**
- **Low Offset Voltage Drift . . . . . . . . . . . . . . . 3µV/°C (Typ)**
- **No Crossover Distortion**
- **Standard Dual Pinout**

### Applications

- **High Quality Audio Preamplifiers**
- **High Q Active Filters**
- **Low Noise Function Generators**
- **Low Distortion Oscillators**
- **Low Noise Comparators**

### Description

Low noise and high performance are key words describing the unity gain stable HA-5102/883. This general purpose dual amplifier offers an array of dynamic specifications including 1V/µs slew rate (min), $A_{VCL} \geq 1$, and 8MHz bandwidth (typ). Complementing these outstanding parameters is a very low noise specification of 4.3nV/√Hz at 1kHz (typ), 6nV/√Hz (max).

Fabricated using the Harris standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 60dB channel separation (min). Economically, the HA-5102/883 also consumes a very moderate amount of supply power 180mW/ package.

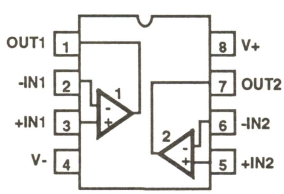
This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

### Ordering Information

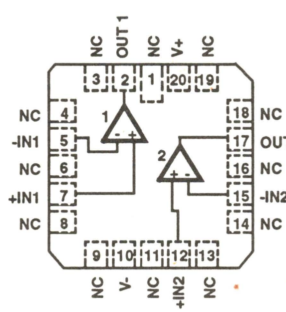
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5102/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5102/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5102/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

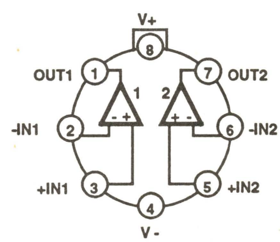
**HA-5102/883 (CERDIP)** TOP VIEW




**HA-5102/883 (CLCC)** TOP VIEW




**HA-5102/883 (METAL CAN)** TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511019-883
File Number 3709

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals . . . . . . . . . . 40V
Differential Input Voltage . . . . . . . . . . 7V
Voltage at Either Input Terminal . . . . . . . . . . V+ to V-
Peak Output Current . . . . . . . . . . Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ($T_J$) . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . . -65°C to +150°C
ESD Rating . . . . . . . . . . <2000V
Lead Temperature (Soldering 10s) . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \le$ +175°C
CerDIP Package . . . . . . . . . . 870mW
Ceramic LCC Package . . . . . . . . . . 1.54W
Metal Can Package . . . . . . . . . . 645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . . . . . . 8.7mW/°C
Ceramic LCC Package . . . . . . . . . . 15.4mW/°C
Metal Can Package . . . . . . . . . . 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range . . . . . . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . . . . . . ±5V to ±15V
$V_{INCM} \le 1/2$ (V+ - V-)
$R_L \ge 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2.0 | 2.0 | mV |
| | | | 2, 3 | +125°C, -55°C | -2.5 | 2.5 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | +12 | - | V |
| | | | 2, 3 | +125°C, -55°C | +12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +5V, V+ = +10V, V- = -20V, $V_{OUT}$ = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -5V, V+ = +20V, V- = -10V, $V_{OUT}$ = +5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -5V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +5V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 5.0 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6.0 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -5.0 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6.0 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +10V, V- = -15V V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -10V V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 4 | +25°C | 1 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 4 | +25°C | 1 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 4 | +25°C | - | 200 | ns |
| | $T_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 4 | +25°C | - | 200 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 4 | +25°C | - | 35 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 4 | +25°C | - | 35 | % |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 250 | - | kΩ |
| Input Noise Voltage Density | $E_N$ | $R_S$ = 20Ω, $f_O$ = 1000Hz | 1 | +25°C | - | 6 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 1000Hz | 1 | +25°C | - | 3 | pA/√Hz |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 16 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | +1 | - | V/V |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 360 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 180 | mW |
| Channel Separation | CS | $R_S$ = 1kΩ, $A_{VCL}$ = 100V/V, $V_{IN}$ = 100m$V_{PEAK}$ at 10kHz Referred to Input | 1 | +25°C | 60 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
98.4 x 67.3 x 19 mils ± 1 mils
2500 x 1710 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
1.43 x $10^5$A/$cm^2$ at 10mA

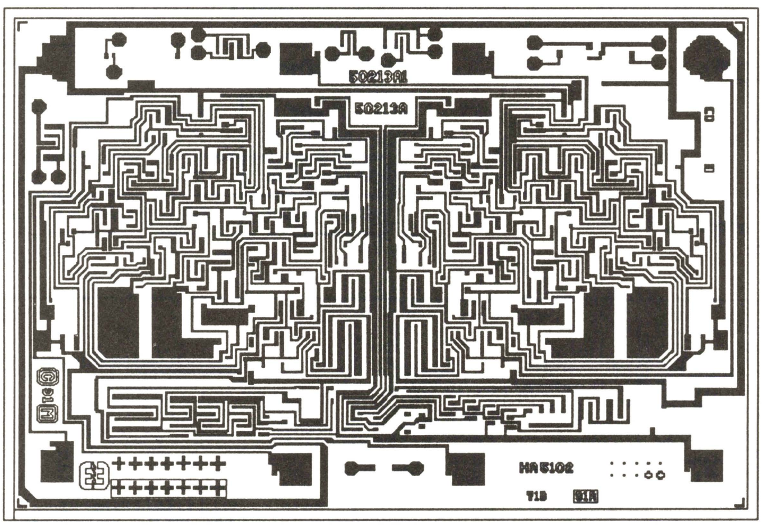
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 93

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5102/883



HARRIS SEMICONDUCTOR

# HA-5104/883

## Low Noise, High Performance, Quad Operational Amplifier

July 1994

### Features

- This Circuit is Processed In Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Input Noise Voltage Density at 1kHz. . 6nV/√Hz (Max) 4.3nV/√Hz (Typ)
- Slew Rate . . . . . . . . . . . . . . . . . . . . . . . . . . 1V/μs (Min) 3V/μs (Typ)
- Unity Gain Bandwidth . . . . . . . . . . . . . . . . . 8MHz (Typ)
- High Open Loop Gain (Full Temp) . . . . . 100kV/V (Min) 250kV/V (Typ)
- High CMRR, PSRR (Full Temp). . . . . . . . . . .86dB (Min) 100dB (Typ)
- Low Offset Voltage Drift . . . . . . . . . . . . . . 3μV/°C (Typ)
- No Crossover Distortion
- Standard Quad Pinout

### Applications

- High Q Active Filters
- Audio Amplifiers
- Integrators
- Signal Generators
- Instrumentation Amplifiers

### Description

Low noise and high performance are key words describing the unity gain stable HA-5104/883. This general purpose quad amplifier offers an array of dynamic specifications including 1V/μs slew rate (min), and 8MHz bandwidth (typ). Complementing these outstanding parameters are very low noise specifications of 4.3nV/√Hz at 1kHz (typ) or 6nV/√Hz (max).

Fabricated using the Harris standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 55dB channel separation (min). Economically, the HA-5104/883 also consumes a very moderate amount of power (225mW per package) while also saving board space and cost.

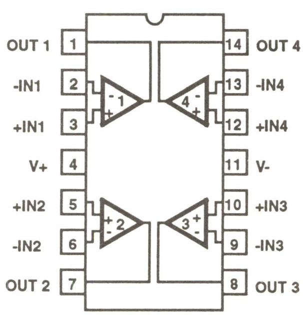
This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

### Ordering Information

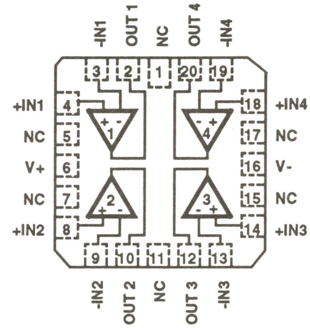
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5104/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5104/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HA-5104/883
(CERDIP)
TOP VIEW




HA-5104/883
(CLCC)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511014-883
File Number 3710

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage .................... 7V
Voltage at Either Input Terminal .................... V+ to V-
Peak Output Current .................... Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ($T_J$) .................... +175°C
Storage Temperature Range .................... -65°C to +150°C
ESD Rating .................... <2000V
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package .................... 1.33W
Ceramic LCC Package .................... 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .................... 13.3mW/°C
Ceramic LCC Package .................... 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range .................... -55°C to +125°C
Operating Supply Voltage .................... ±5V to ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2.5 | 2.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -3.0 | 3.0 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | +12 | - | V |
| | | | 2, 3 | +125°C, -55°C | +12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +5V, V+ = +10V, V- = -20V, $V_{OUT}$ = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -5V, V+ = +20V, V- = -10V, $V_{OUT}$ = +5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT1}$ | $R_L = 2k\Omega$ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L = 2k\Omega$ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L = 10k\Omega$ | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT2}$ | $R_L = 10k\Omega$ | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT} = -5V$ | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +5V$ | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 6.5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7.5 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -6.5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7.5 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$,<br>V+ = +10V, V- = -15V<br>V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$,<br>V+ = +15V, V- = -10V<br>V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT} = -3V$ to $+3V$ | 4 | +25°C | 1 | - | V/µs |
| | -SR | $V_{OUT} = +3V$ to $-3V$ | 4 | +25°C | 1 | - | V/µs |
| Rise and Fall Time | $T_R$ | $V_{OUT} = 0$ to $+200mV$<br>$10\% \le T_R \le 90\%$ | 4 | +25°C | - | 200 | ns |
| | $T_F$ | $V_{OUT} = 0$ to $-200mV$<br>$10\% \le T_F \le 90\%$ | 4 | +25°C | - | 200 | ns |
| Overshoot | +OS | $V_{OUT} = 0$ to $+200mV$ | 4 | +25°C | - | 35 | % |
| | -OS | $V_{OUT} = 0$ to $-200mV$ | 4 | +25°C | - | 35 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = 1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 250 | - | kΩ |
| Input Noise Voltage Density | $E_N$ | $R_S$ = 20Ω, $f_O$ = 1000Hz | 1 | +25°C | - | 6 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 1000Hz | 1 | +25°C | - | 3 | pA/√Hz |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 32 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | +1 | - | V/V |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 270 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 225 | mW |
| Channel Separation | CS | $R_S$ = 1kΩ, $A_{VCL}$ = 100V/V, $V_{IN}$ = 100m$V_{PEAK}$ at 10kHz Referred to Input | 1 | +25°C | 55 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
95 x 99 x 19 mils ± 1 mils
2420 x 2530 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.43 \times 10^5$ A/cm$^2$

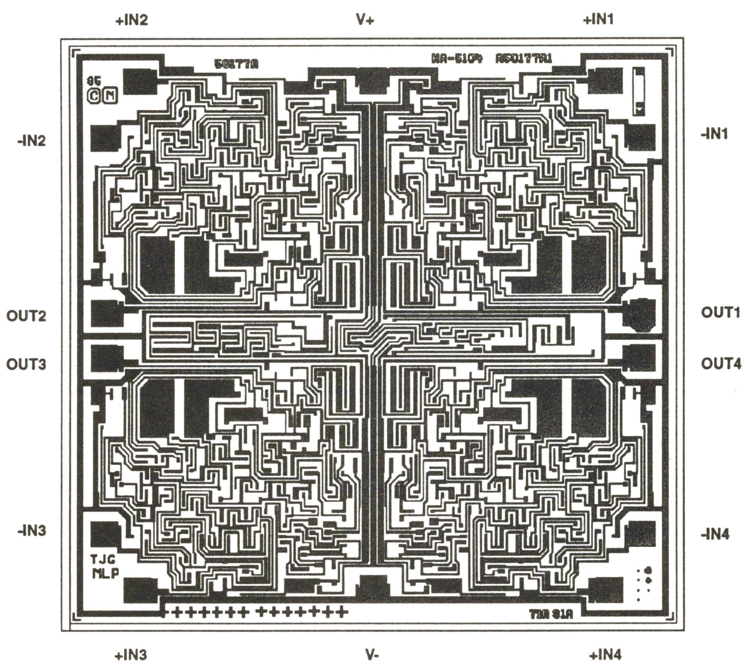
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 175

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA5104/883



HARRIS SEMICONDUCTOR

# HA-5112/883

## Dual, Low Noise, High Performance Uncompensated Operational Amplifier

July 1994



### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Input Noise Voltage Density at 1kHz . . . 6nV/√Hz(Max) 4.3nV/√Hz(Typ)
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . 12V/μs (Min) 20V/μs (Typ)
- Wide Gain Bandwidth Product ($A_{VCL}$ ≥ 10) . . . . 54MHz
- Low Offset Voltage Drift . . . . . . . . . . . . . . 3μV/°C (Typ)
- High Open Loop Gain (Full Temp.) . . . . . 100kV/V (Min) 250kV/V (Typ)
- High CMRR/PSRR (Full Temp.) . . . . . . . . . . . 86dB (Min) 100dB (Typ)
- Low Offset Voltage Drift . . . . . . . . . . . . . . 3μV/°C (Typ)
- No Crossover Distortion
- Standard Dual Pinout

### Applications

- High Quality Audio Preamplifiers
- High Q Active Filters
- Low Noise Function Generators
- Low Distortion Oscillators
- Low Noise Comparators

### Description

Low Noise and high performance are key words describing the dual, uncompensated HA-5112/883. This general purpose amplifier offers an array of dynamic specifications including 12V/μs slew rate (min), and 54MHz gain-bandwidth-product for $A_{VCL}$ ≥ 10. Complementing these outstanding parameters is a very low noise specification of 6nV/√Hz at 1kHz (max).

Fabricated using the Harris standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 55dB channel separation (min). The HA-5112/883 also consumes a very modest amount of supply power (180mW/package).

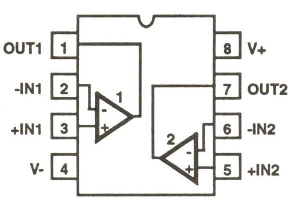
This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

### Ordering Information

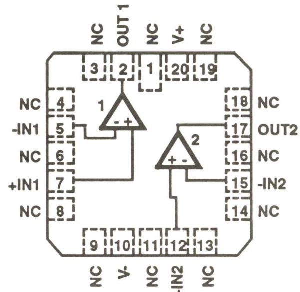
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5112/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5112/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5112/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

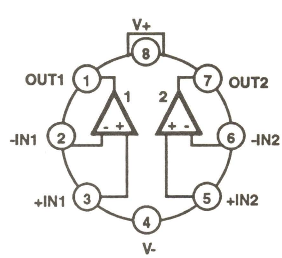
HA-5112/883
(CERDIP)
TOP VIEW




HA-5112/883
(CLCC)
TOP VIEW




HA-5112/883
(METAL CAN)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511032-883
File Number 3711

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 40V
Differential Input Voltage.................................. 7V
Voltage at Either Input Terminal ......................... V+ to V-
Peak Output Current................................ Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ($T_J$) ............................ +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating.......................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package ................................ 870mW
Ceramic LCC Package ............................ 1.54W
Metal Can Package .............................. 645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................ 8.7mW/°C
Ceramic LCC Package ...................... 15.4mW/°C
Metal Can Package ......................... 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage.......................... ±5V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2.0 | 2.0 | mV |
| | | | 2, 3 | +125°C, -55°C | -2.5 | 2.5 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | +12 | - | V |
| | | | 2, 3 | +125°C, -55°C | +12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +5V, V+ = +10V, V- = -20V, $V_{OUT}$ = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -5V, V+ = +20V, V- = -10V, $V_{OUT}$ = +5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 10kΩ | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -5V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +5V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +10V, V- = -15V V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -10V V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Parameters in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = 10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 250 | - | kΩ |
| Input Noise Voltage | $E_N$ | $R_S$ = 20Ω, $f_O$ = 1000Hz | 1 | +25°C | - | 6 | nV/√Hz |
| Input Noise Current | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 1000Hz | 1 | +25°C | - | 3 | pA/√Hz |

3 OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = 10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O = 200mV$, $f_O = 50kHz$ | 1 | +25°C | 40 | - | MHz |
| | | $V_O = 200mV$, $f_O = 1MHz$ | 1 | +25°C | 54 | - | MHz |
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 1 | +25°C | 12 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 1 | +25°C | 12 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 191 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 10 | - | V/V |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 100 | ns |
| | $t_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 100 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = OV to -200mV | 1 | +25°C | - | 40 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 232 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 180 | mW |
| Channel Separation | CS | $R_S = 1k\Omega$, $A_{VCL} = 100V/V$, $V_{IN} = 100mV_{PEAK}$ at 10kHz, Referred to Input | 1 | +25°C | 55 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
98.4 x 67.3 x 19 mils ± 1 mils
2500 x 1710 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.43 \times 10^5 A/cm^2$ at 10mA

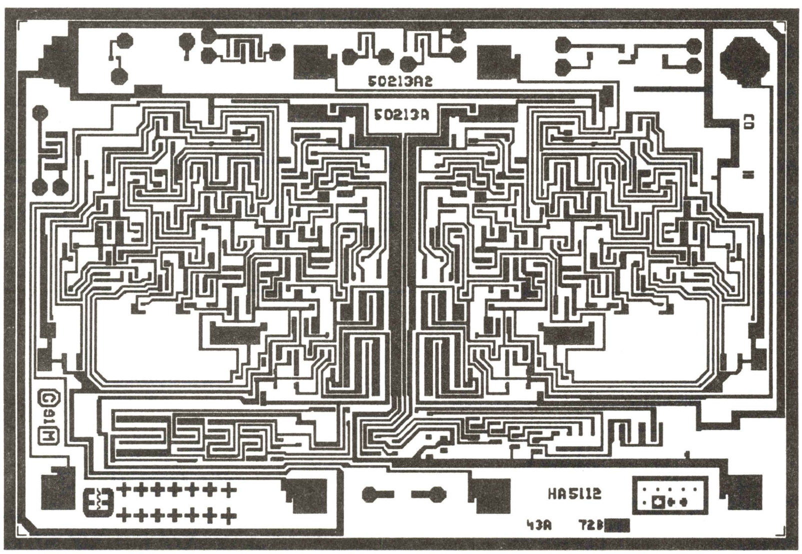
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 93

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5112/883




3 OPERATIONAL AMPLIFIERS

# HARRIS SEMICONDUCTOR

# HA-5114/883

## Quad, Low Noise, High Performance Uncompensated Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Input Noise Voltage Density at 1kHz... 6nV/√Hz(Max) 4.3nV/√Hz (Typ)
- High Slew Rate ...................... 12V/µs (Min) 20V/µs (Typ)
- Wide Gain Bandwidth Product ($A_{VCL} \geq 10$)... 40MHz (Typ)
- High Open Loop Gain (Full Temp) ..... 100kV/V (Min) 250kV/V (Typ)
- High CMRR, PSRR (Full Temp)...........86dB (Min) 100dB (Typ)
- Low Offset Voltage Drift .............. 3µV/°C (Typ)
- No Crossover Distortion
- Standard Quad Pinout

### Applications

- High Quality Audio Preamplifiers
- High Q Active Filters
- Low Noise Function Generators
- Low Distortion Oscillators
- Low Noise Comparators

### Description

Low noise and high performance are key words describing the quad, uncompensated HA-5114/883. This general purpose amplifier offers an array of dynamic specifications including 12V/µs slew rate (min), and 40MHz gain-bandwidth-product for $A_{VCL} \geq 10$. Complementing these outstanding parameters is a very low noise specification of 6nV/√Hz at 1kHz (max).

Fabricated using the Harris standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 55dB channel separation (min). Economically, HA-5114/883 also consumes a very modest amount of power (225mW/ package), while also saving board space and cost.

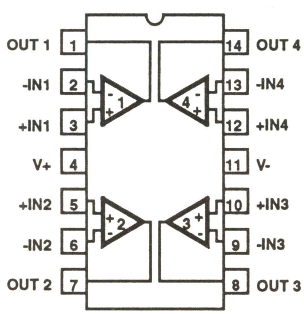
This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

### Ordering Information

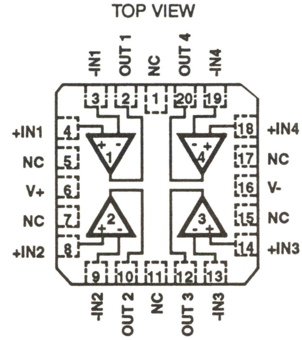
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5114/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5114/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HA-5114/883
(CERDIP)
TOP VIEW




HA-5114/883
(CLCC)
TOP VIEW








File Number 511015-883
File Number 3712

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals .................... 40V
Differential Input Voltage.................................. 7V
Voltage at Either Input Terminal ...................... V+ to V-
Peak Output Current............................. Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating.......................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package ................................. 1.33W
Ceramic LCC Package ............................ 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................ 13.3mW/°C
Ceramic LCC Package ....................... 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage......................... ±5V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -2.5 | 2.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -3.0 | 3.0 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | +12 | - | V |
| | | | 2, 3 | +125°C, -55°C | +12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +5V, V+ = +10V, V- = -20V, $V_{OUT}$ = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -5V, V+ = +20V, V- = -10V, $V_{OUT}$ = +5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

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OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L = 2k\Omega$ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L = 2k\Omega$ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L = 10k\Omega$ | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT2}$ | $R_L = 10k\Omega$ | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT} = -5V$ | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +5V$ | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 6.5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 7.5 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -6.5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -7.5 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +10V, V- = -15V V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -10V V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Parameters in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = 10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 250 | - | kΩ |
| Input Noise Voltage | $E_N$ | $R_S = 20\Omega$, $f_O = 1000Hz$ | 1 | +25°C | - | 6 | nV/√Hz |
| Input Noise Current | $I_N$ | $R_S = 2M\Omega$, $f_O = 1000Hz$ | 1 | +25°C | - | 3 | pA/√Hz |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = 10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Gain Bandwidth Product | GBWP | $V_O = 200mV$, $f_O = 30kHz$ | 1 | +25°C | 34 | - | MHz |
| | | $V_O = 200mV$, $f_O = 1MHz$ | 1 | +25°C | 40 | - | MHz |
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V | 1 | +25°C | 12 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V | 1 | +25°C | 12 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 191 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 10 | - | V/V |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | +25°C | - | 100 | ns |
| | $t_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | +25°C | - | 100 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | +25°C | - | 40 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 270 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 225 | mW |
| Channel Separation | CS | $R_S = 1k\Omega$, $A_{VCL} = 100V/V$, $V_{IN} = 100mV_{PEAK}$ at 10kHz Referred to Input | 1 | +25°C | 55 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

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OPERATIONAL AMPLIFIERS

## Die Characteristics

**DIE DIMENSIONS:**
99.6 x 95.3 x 19 mils ± 1 mils
2530 x 2420 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.43 \times 10^5 A/cm^2$ at 10mA

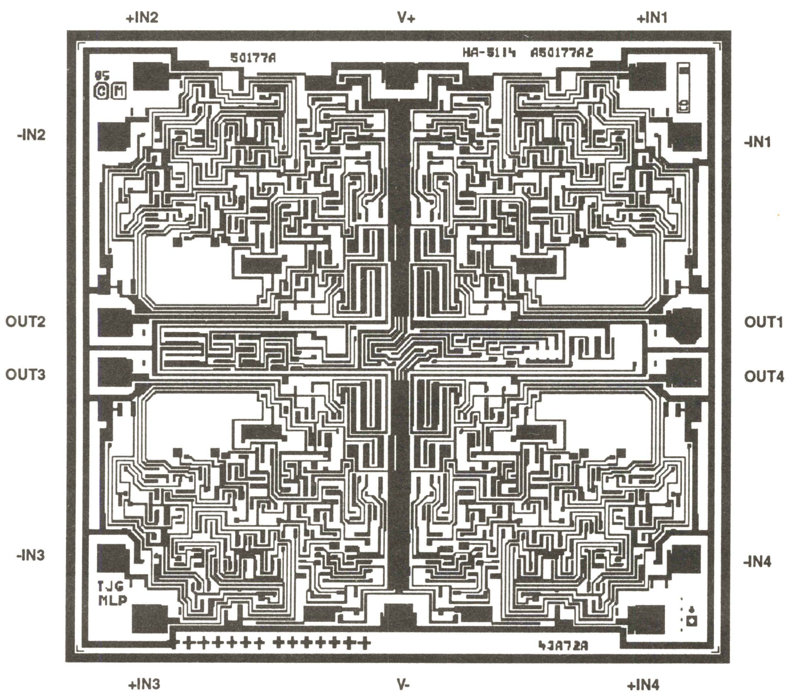
**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 175

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5114/883



# HARRIS SEMICONDUCTOR

# HA-5127/883

July 1994

## Ultra Low Noise, Precision Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . . . 7V/µs (Min)
- Unity Gain Bandwidth . . . . . . . . . . . . . . . . . 5MHz (Min)
- Low Noise Voltage (at 1kHz) . . . . . . . . $4.5nV/\sqrt{Hz}$ (Max)
- Low Offset Voltage. . . . . . . . . . . . . . . . . . . .100µV (Max)
- Low Offset Drift With Temperature. . . . 1.8µV/°C (Max)
- High CMRR . . . . . . . . . . . . . . . . . . . . . . . . .100dB (Min)
- High Voltage Gain . . . . . . . . . . . . . . . . . . 700kV/V (Min)

### Applications

- High Speed Signal Conditioners
- Wide Bandwidth Instrumentation Amplifiers
- Low Level Transducer Amplifiers
- Fast, Low Level Voltage Comparators
- Highest Quality Audio Preamplifiers
- Pulse/RF Amplifiers

The HA-5127/883 monolithic operational amplifier features an excellent combination of precision DC and wideband high speed characteristics. Utilizing the Harris D.I. technology and advanced processing techniques, this unique design unites low noise precision instrumentation performance with high speed, wideband capability.

This amplifier's impressive list of features include low $V_{OS}$, wide gain-bandwidth, high open loop gain, and high CMRR. Additionally, this flexible device operates over a wide supply range while consuming only 120mW of power.

Using the HA-5127/883 allows designers to minimize errors while maximizing speed and bandwidth.

This device is ideally suited for low level transducer signal amplifier circuits. Other applications which can utilize the HA-5127/883's qualities include instrumentation amplifiers, pulse or RF amplifiers, audio preamplifiers, and signal conditioning circuits.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5127/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5127/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5127/883 | -55°C to +125°C | 8 Lead CerDIP |

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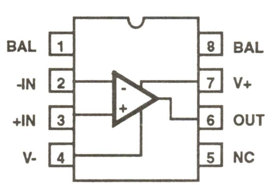
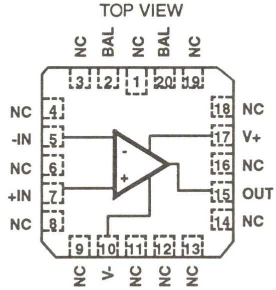
OPERATIONAL AMPLIFIERS

### Pinouts

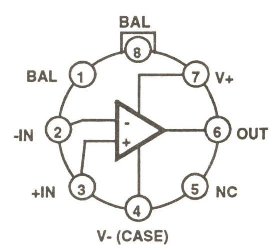
HA-5127/883
(CERDIP)
TOP VIEW




HA-5127/883
(CLCC)
TOP VIEW




HA-5127/883
(METAL CAN)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511008-883
File Number 3751

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 44V
Differential Input Voltage (Note 2). ........................ 0.7V
Voltage at Either Input Terminal ...................... V+ to V-
Input Current. ........................................ 25mA
Differential Output Current .......... Full Short Circuit Protection
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating. ........................................ <2000V
Lead Temperature (Soldering 10s). ................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Ceramic LCC Package ........................... 1.54W
Metal Can Package ............................. 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package .............................. 8.7mW/°C
Ceramic LCC Package ........................ 15.4mW/°C
Metal Can Package ........................... 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Recommended Operating Conditions

Operating Temperature Range. ............... -55°C to +125°C
Operating Supply Voltage. ............................. ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 600\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -100 | 100 | µV |
| | | | 2, 3 | +125°C, -55°C | -300 | 300 | µV |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V, $R_S$ = 10kΩ, 50Ω $\left(\frac{\lvert +I_B \rvert + \lvert -I_B \rvert}{2}\right)$ | 1 | +25°C | - | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | - | 150 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -135 | 135 | nA |
| Common Mode Range | +CMR | V+ = +4.7V, V- = -25.3V | 1 | +25°C | 10.3 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10.3 | - | V |
| | -CMR | V+ = +25.3V, V- = -4.7V | 1 | +25°C | - | -10.3 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10.3 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = +10V | 2, 3 | +125°C, -55°C | 100 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = -10V | 2, 3 | +125°C, -55°C | 100 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | 11.5 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11.5 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -11.5 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11.5 | V |
| | $+V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | 10 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 16.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -16.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 4 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -4 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 14V | 1 | +25°C | 86 | - | dB |
| | | $\Delta V_{SUP}$ = 13.5V | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 14V | 1 | +25°C | 86 | - | dB |
| | | $\Delta V_{SUP}$ = 13.5V | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}$Adj | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}$Adj | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$ (Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. For differential input voltages greater than 0.7V, the input current must be limited to 25mA to protect the back-to-back input diodes.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 7 | +25°C | 7 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 7 | +25°C | 7 | - | V/µs |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0 to +200mV<br>10% ≤ $T_R$ ≤ 90% | 7 | +25°C | - | 150 | ns |
| | $t_F$ | $V_{OUT}$ = 0 to -200mV<br>10% ≤ $T_F$ ≤ 90% | 7 | +25°C | - | 150 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | % |

### TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | LIMITS UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 1.8 | µV/°C |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 0.8 | - | MΩ |
| Low Frequency Peak-to-Peak Noise | $E_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 0.25 | $\mu V_{P-P}$ |
| Input Noise Voltage Density | $E_N$ | $R_S = 20\Omega$, $f_O = 10Hz$ | 1 | +25°C | - | 10.0 | $nV/\sqrt{Hz}$ |
| | | $R_S = 20\Omega$, $f_O = 100Hz$ | 1 | +25°C | - | 5.6 | $nV/\sqrt{Hz}$ |
| | | $R_S = 20\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 4.5 | $nV/\sqrt{Hz}$ |
| Input Noise Current Density | $I_N$ | $R_S = 2M\Omega$, $f_O = 10Hz$ | 1 | +25°C | - | 4.0 | $pA/\sqrt{Hz}$ |
| | | $R_S = 2M\Omega$, $f_O = 100Hz$ | 1 | +25°C | - | 2.3 | $pA/\sqrt{Hz}$ |
| | | $R_S = 2M\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 0.6 | $pA/\sqrt{Hz}$ |
| Unity Gain Bandwidth | UGBW | $V_O = 100mV$ | 1 | +25°C | 5 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 111 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | ±1 | - | V/V |
| Settling Time | $t_S$ | To 0.1% for a 10V Step | 1 | +25°C | - | 2 | µs |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 100 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 120 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on output.)

### TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) (NOTE 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTES:

1. PDA applies to Subgroup 1 only.
2. The Subgroup assignments of the parameters in these tables were patterned after Mil-M-38510/135, with the exception of $V_{IO}$, which is Subgroups 1, 2, 3.

## Die Characteristics

**DIE DIMENSIONS:**
104 x 65 x 19 mils ± 1 mils
2650 x 1650 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.6 \times 10^5 A/cm^2$
This device meets Glassivation Integrity Test Requirement per MIL-STD-883 Method 2021 and MIL-I-38535 Paragraph 30.5.5.4.

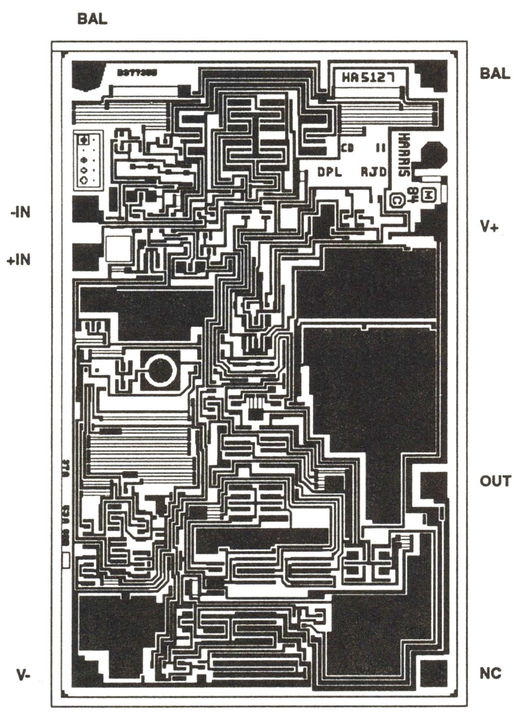
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 63

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5127/883



HARRIS SEMICONDUCTOR

# HA-5134/883

July 1994

## Precision Quad Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Offset Voltage (+25°C) .............200μV (Max)
  (Full Temp.) ............350μV (Max)
- Low Offset Voltage Drift at Temp. ........ 2μV/°C (Max)
- Offset Voltage Match ..................350μV (Max)
- High Channel Separation ..............120dB (Min)
- Low Noise (f ≥ 100Hz) .............. 10nV/√Hz (Max)
- Wide Bandwidth ...................... 4MHz (Typ)
- High CMRR/PSRR ....................100dB (Min)
- High Voltage Gain .................. 800kV/V (Min)
- Dielectric Isolation

### Applications

- Instrumentation Amplifiers
- State-Variable Filters
- Precision Integrators
- Threshold Detectors
- Precision Data Acquisition Systems
- Low-Level Transducer Amplifiers

### Description

The HA-5134/883 is a precision quad operational amplifier that is pin compatible with the OP-400, LT1014, OP11, RM4156, and LM148 as well as the HA-4741/883. Each amplifier features guaranteed maximum values for offset voltage of 350μV, offset voltage drift of 2μV/°C (max), and offset current of 75nA over the full military temperature range while CMRR/PSRR is guaranteed greater than 94dB and open loop gain is guaranteed above 500kV/V from -55°C to +125°C. Room temperature specifications exceed these values such as an offset voltage matching specification between channels of 200μV (max) at +25°C.

Precision performance of the HA-5134/883 is enhanced by a noise voltage density of 7nV/√Hz at 1kHz (typ), noise current density of 2pA/√Hz at 1kHz and channel separation of 120dB (min). Each of the four unity gain stable amps on the quad are electrically isolated, having only supply lines in common and are fabricated using Dielectric Isolation to insure quality performance in the most demanding applications.

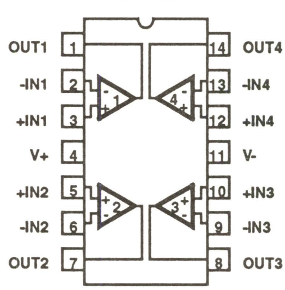
The HA-5134/883 is ideal for compact circuits such as instrumentation amplifiers, state-variable filters, and low level transducer amplifiers. Other applications include precision data acquisition systems, precision integrators, and accurate threshold detectors in designs where board space is a limitation.

### Ordering Information

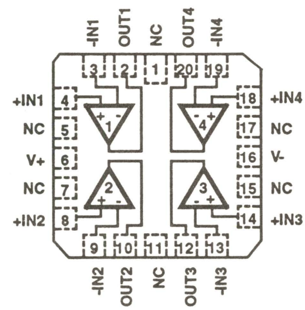
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5134/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5134/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HA-5134/883
(CERDIP)
TOP VIEW




HA-5134/883
(CLCC)
TOP VIEW








Spec Number 511033-883
File Number 3713

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage................................ 6V
Voltage at Either Input Terminal ...................... V+ to V-
Input Current........................................ 25mA
Output Current .................. Full Short Circuit Protection
Output Current Duration ......................... Indefinite
(One Amplifier Shorted to Ground)
Junction Temperature ............................ +175°C
Storage Temperature Range ................ -65°C to +150°C
ESD Rating.................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 1.33W
Ceramic LCC Package ............................ 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................ 13.3mW/°C
Ceramic LCC Package ........................ 15.4mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage.............................. ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 2k\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -200 | 200 | µV |
| | | | 2, 3 | +125°C, -55°C | -350 | 350 | µV |
| Offset Voltage Match | $\Delta V_{IO}$ | $\lvert V_{IO}$ (Max) $- V_{IO}$ (Min)$\rvert$ | 1 | +25°C | - | 200 | µV |
| | | | 2, 3 | +125°C, -55°C | - | 350 | µV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 50Ω | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 50Ω, $-R_S$ = 10kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| Common Mode Range | +CMR | V+ = +5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | V+ = +25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 800 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 500 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 800 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 500 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = 10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | 12 | - | V |
| | | | 5, 6 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -12 | V |
| | | | 5, 6 | +125°C, -55°C | - | -12 | V |

3
OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 15 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 8 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -15 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -8 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 6.8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 8 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 6.8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 8 | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +20V, V- = -15V V+ = +10V, V- = -15V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -20V V+ = +15V, V- = -10V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 7 | +25°C | 0.75 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 7 | +25°C | 0.75 | - | V/µs |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0 to +200mV $10\% \le T_R \le 90\%$ | 7 | +25°C | - | 400 | ns |
| | $t_F$ | $V_{OUT}$ = 0 to -200mV $10\% \le T_F \le 90\%$ | 7 | +25°C | - | 400 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 2 | µV/°C |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 20 | - | MΩ |
| Low Frequency Peak-to-Peak Noise | $E_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 0.25 | $\mu V_{P-P}$ |
| Input Noise Voltage Density | $E_N$ | $R_S = 20\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 10 | $nV/\sqrt{Hz}$ |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Noise Current Density | $I_N$ | $R_S = 2M\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 2 | $pA/\sqrt{Hz}$ |
| Gain Bandwidth Product | GBWP | $V_O = 200mV$, $f_O \geq 100kHz$ | 1 | +25°C | 3 | - | MHz |
| Unity Bandwidth Product | UBWP | $V_O = 200mV$ | 1 | +25°C | 3 | - | MHz |
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 1 | +25°C to +125°C | 0.75 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 1 | -55°C | 0.6 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 12 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | +1 | - | V/V |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0V to +200mV | 1, 4 | -55°C to +125°C | - | 400 | ns |
| | $t_F$ | $V_{OUT}$ = 0V to -200mV | 1, 4 | -55°C to +125°C | - | 400 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0V to +200mV | 1 | -55°C to +125°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0V to -200mV | 1 | -55°C to +125°C | - | 40 | % |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 86 | Ω |
| Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 240 | mW |
| Channel Separation (AC) | CS (AC) | $V_{IN} = 1V_{P-P}$, $f_O = 100Hz$ | 1 | +25°C | 120 | - | dB |
| | | $V_{IN} = 1V_{P-P}$, $f_O = 10kHz$ | 1 | +25°C | 120 | - | dB |
| Channel Separation (DC) | CS (DC) | $V_O = \pm10V$ ($20V_{P-P}$), $\Delta V_{IO} \leq 20\mu V$ | 1 | +25°C | 120 | - | dB |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

3

OPERATIONAL AMPLIFIERS

## Die Characteristics

**DIE DIMENSIONS:**
91 x 114 x 19 mils ± 1 mils
2300 x 2900 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

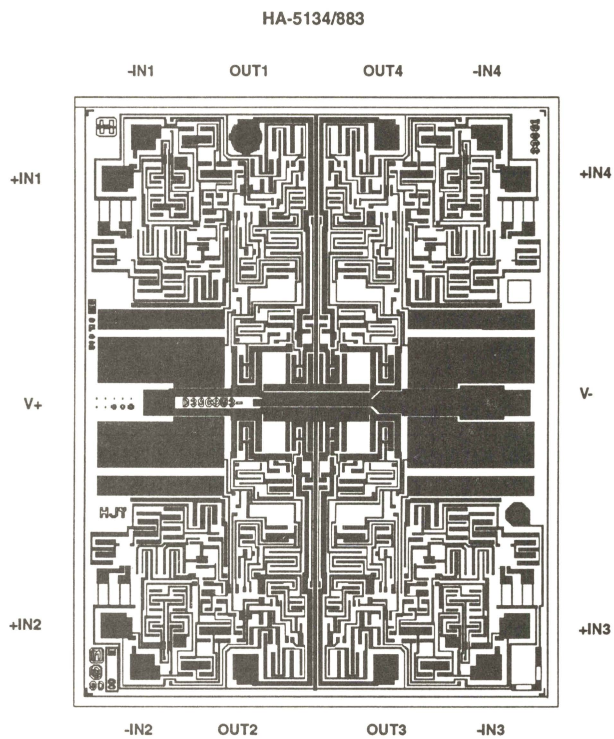
**WORST CASE CURRENT DENSITY:**
$2.5 \times 10^5 A/cm^2$
This device meets Glassivation Integrity Test Requirement
per MIL-STD-883 Method 2021 and MIL-I-38535 Paragraph 30.5.5.4.

**SUBSTRATE POTENTIAL (Powered Up):**
Unbiased

**TRANSISTOR COUNT:** 160

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout




Spec Number **511033-883**

# HA-5135/883

July 1994

## Precision Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Offset Drift .................... 0.4μV/°C (Max)
- Low Offset Voltage.....................75μV (Max)
- High Gain ..................... 120dB(1MV/V) (Min)
- High CMRR..........................106dB (Min)
- High PSRR ..........................94dB (Min)
- Low Supply Current.................. 1.7mA (Max)
- Low Noise Voltage Density at 1kHz .....9nV/√Hz (Max)
- Low Noise Current Density at 1kHz.... 0.4pA/√Hz (Max)

### Applications

- High Gain Instrumentation
- Precision Data Acquisition
- Precision Integrators
- Biomedical Amplifiers
- Precision Threshold Detectors

### Description

The HA-5135/883 is a precision operational amplifier manufactured using a combination of key technological advancements to provide outstanding input characteristics.

A high Beta input stage is combined with laser trimming, dielectric isolation, and matching techniques to produce 75μV (max) input offset voltage and 0.4μV/°C (max) input offset voltage average drift. Other features enhanced by this process include 9nV/√Hz (typ) Input Noise Voltage, 4nA Input Bias Current (max) and 120dB Open Loop Gain (min).

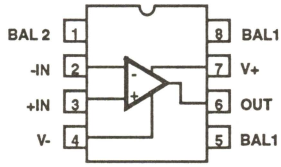
These features coupled with 106dB CMRR and 94dB PSRR make HA-5135/883 an ideal device for precision D.C. instrumentation amplifiers. Excellent input characteristics in conjunction with 0.6MHz (min) bandwidth and 0.5V/μs (min) slew rate, makes this amplifier extremely useful for precision integrator and biomedical amplifier designs. These amplifiers are also well suited for precision data acquisition and for accurate threshold detector applications.

### Ordering Information

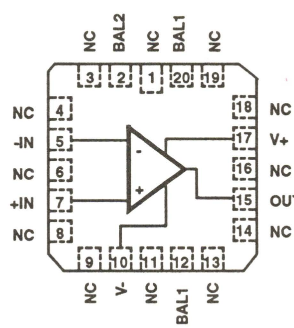
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5135/883 | -55°C to +125°C | 8 Pin Can |
| HA7-5135/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA4-5135/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

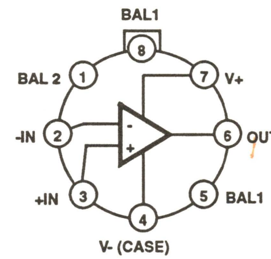
HA-5135/883
(CERDIP)
TOP VIEW




HA-5135/883
(CLCC)
TOP VIEW




HA-5135/883
(METAL CAN)
TOP VIEW






CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511016-883**
File Number **3731.1**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage (Note 2)......................... 7V
Voltage at Either Input Terminal ...................... V+ to V-
Input Current ........................................ 25mA
Output Current .................... Full Short Circuit Protection
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating......................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Ceramic LCC Package .............................. 1.54W
Metal Can Package ............................. 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................. 8.7mW/°C
Ceramic LCC Package ........................ 15.4mW/°C
Metal Can Package ........................... 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage ............................... ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 600\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -75 | 75 | µV |
| | | | 2, 3 | +125°C, -55°C | -130 | 130 | µV |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V, $R_S$ = 10kΩ, 50Ω $\left(\frac{\lvert +I_B\rvert + \lvert -I_B\rvert}{2}\right)$ | 1 | +25°C | -4 | 4 | nA |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -4 | 4 | nA |
| | | | 2, 3 | +125°C, -55°C | -5.5 | 5.5 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 120 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 120 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 120 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 120 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 106 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 106 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 106 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 106 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 600Ω | 4 | +25°C | 10 | - | V |
| | | | 5, 6 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT}$ | $R_L$ = 600Ω | 4 | +25°C | - | -10 | V |
| | | | 5, 6 | +125°C, -55°C | - | -10 | V |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 15 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -15 | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 1.7 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 1.7 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -1.7 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -1.7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +5V, V- = -15V, V+ = +15V, V- = -15V | 1 | +25°C | 94 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -5V, V+ = +15V, V- = -15V | 1 | +25°C | 94 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTES:

1. Offset adjustment range is [$V_{IO}$ (Measured ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. The input stage has series 500Ω resistors along with back to back diodes. This provides large differential input voltage protection for a slight increase in noise voltage.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V, $V_{IN}$ S.R. ≤ 25V/µs | 7 | +25°C | 0.5 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V, $V_{IN}$ S.R. ≤ 25V/µs | 7 | +25°C | 0.5 | - | V/µs |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 1.3 | µV/°C |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 20 | - | MΩ |
| Average Offset Current Drift | $I_{IO}TC$ | Versus Temperature $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 40 | pA/°C |
| Average Bias Current Drift | $I_BTC$ | Versus Temperature $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 40 | pA/°C |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_V$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Noise Voltage Density | $E_N$ | $R_S$ = 20Ω, $f_O$ = 1kHz | 1 | +25°C | - | 11 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 1kHz | 1 | +25°C | - | 0.4 | pA/√Hz |
| Unity Gain Bandwidth | UGBW | $V_{OUT}$ = ±100mV, $f_O$ at -3dB | 1 | +25°C | 600 | - | kHz |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 8 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | +1 | - | V/V |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 80 | Ω |
| Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 51 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
72 x 103 x 19 mils ± 1 mils
1840 x 2620 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$6.0 \times 10^4 A/cm^2$

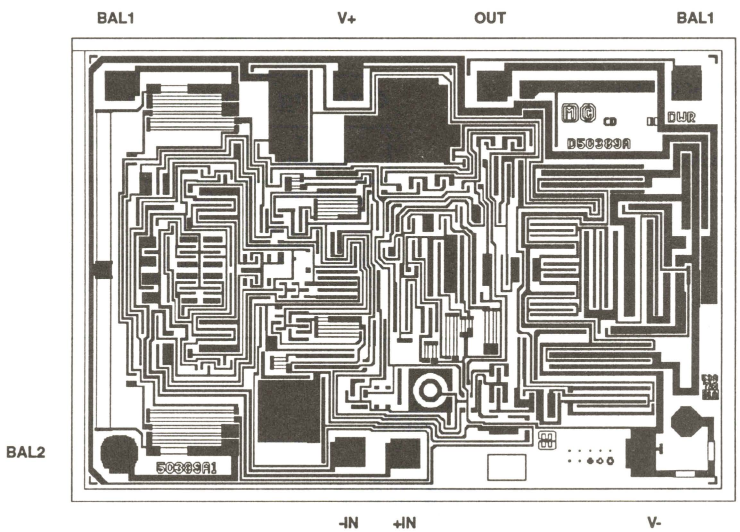
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 71

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5135/883



HARRIS SEMICONDUCTOR

# HA-5137/883

## Ultra Low Noise, Precision Wideband Operational Amplifier

July 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **High Slew Rate . . . . . . . . . . 14V/µs (Min)**
- **Wide Gain Bandwidth ($A_V \geq 5$) . . . . . . . . . 60MHz (Min)**
- **Low Noise (at 1kHz) . . . . . . . . . 4.5nV/$\sqrt{Hz}$ (Max)**
- **Low Offset Voltage . . . . . . . . . 100µV (Max)**
- **Low Offset Drift With Temperature . . . . 1.8µV/°C (Max)**
- **High CMRR . . . . . . . . . 100dB (Min)**
- **High Voltage Gain . . . . . . . . . 700kV/V (Min)**

### Applications

- **High Speed Signal Conditioners**
- **Wide Bandwidth Instrumentation Amplifiers**
- **Low Level Transducer Amplifiers**
- **Fast, Low Level Voltage Comparators**
- **Highest Quality Audio Preamplifiers**
- **Pulse/RF Amplifiers**

### Description

The HA-5137/883 monolithic operational amplifier features an excellent combination of precision DC and wideband high speed characteristics. Utilizing the Harris DI technology and advanced processing techniques, this unique design unites low noise precision instrumentation performance with high speed, wideband capability.

This amplifier's impressive list of features include low $V_{OS}$, wide gain-bandwidth, high open loop gain, and high CMRR. Additionally, this flexible device operates over a wide supply range while consuming only 120mW of power.

Using the HA-5137/883 allows designers to minimize errors while maximizing speed and bandwidth in applications requiring gains greater than five.

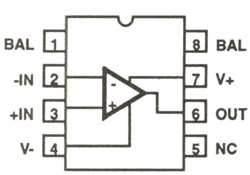
This device is ideally suited for low level transducer signal amplifier circuits. Other applications which can utilize the HA-5137/883's qualities include instrumentation amplifiers, pulse or RF amplifiers, audio preamplifiers, and signal conditioning circuits.

### Ordering Information

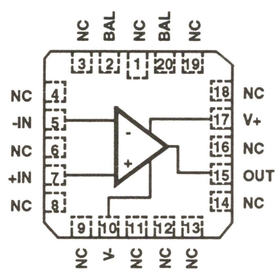
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5137/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5137/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5137/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

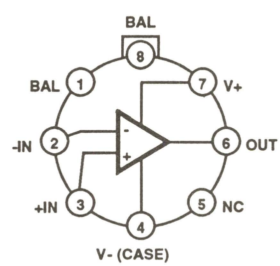
HA-5137/883
(CERDIP)
TOP VIEW




HA-5137/883
(CLCC)
TOP VIEW




HA-5137/883
(METAL CAN)
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals . . . . . 44V
Differential Input Voltage (Note 2) . . . . . 0.7V
Voltage at Either Input Terminal . . . . . V+ to V-
Input Current . . . . . 25mA
Differential Output Current . . . . . Full Short Circuit Protection
Junction Temperature ($T_J$) . . . . . +175°C
Storage Temperature Range . . . . . -65°C to +150°C
ESD Rating . . . . . <2000V
Lead Temperature (Soldering 10s) . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \le$ +175°C
CerDIP Package . . . . . 870mW
Ceramic LCC Package . . . . . 1.54W
Metal Can Package . . . . . 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 8.7mW/°C
Ceramic LCC Package . . . . . 15.4mW/°C
Metal Can Package . . . . . 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . ±15V
$V_{INCM} \le 1/2$ (V+ - V-)
$R_L \ge 600\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -100 | 100 | µV |
| | | | 2, 3 | +125°C, -55°C | -300 | 300 | µV |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V, $R_S$ = 10kΩ, 50Ω $\left(\frac{\lvert +I_B\rvert + \lvert -I_B\rvert}{2}\right)$ | 1 | +25°C | - | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | - | 150 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -135 | 135 | nA |
| Common Mode Range | +CMR | V+ = +4.7V, V- = -25.3V | 1 | +25°C | 10.3 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10.3 | - | V |
| | -CMR | V+ = +25.3V, V- = -4.7V | 1 | +25°C | - | -10.3 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10.3 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = +10V | 2, 3 | +125°C, -55°C | 100 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = -10V | 2, 3 | +125°C, -55°C | 100 | - | dB |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | 11.5 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11.5 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -11.5 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11.5 | V |
| | $+V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | 10 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = -10V | 4 | +25°C | 16.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = +10V | 4 | +25°C | - | -16.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 4 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -4 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 14V, V+ = +4V, V- = -15V, V+ = +18V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 14V, V+ = +15V, V- = -4V, V+ = +15V, V- = -18V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTES:

1. Offset adjustment range is [$V_{IO}$ (Measured ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. For differential input voltages greater than 0.7V, the input current must be limited to 25mA to protect the back-to-back input diodes.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_{VCL}$ = +10V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -3V to +3V | 7 | +25°C | 14 | - | V/µs |
| | -SR | $V_{OUT}$ = +3V to -3V | 7 | +25°C | 14 | - | V/µs |
| Rise and Fall Time | $t_R$ | $V_{OUT}$ = 0 to +200mV 10% ≤ $T_R$ ≤ 90% | 7 | +25°C | - | 100 | ns |
| | $t_F$ | $V_{OUT}$ = 0 to -200mV 10% ≤ $T_F$ ≤ 90% | 7 | +25°C | - | 100 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0 to +200mV | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT}$ = 0 to -200mV | 7 | +25°C | - | 40 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_V$ = +5V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM}$ = 0V | 1 | -55°C to +125°C | - | 1.8 | µV/°C |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_V$ = +5V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 0.8 | - | MΩ |
| Low Frequency Peak-to-Peak Noise | $E_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 0.25 | $\mu V_{P-P}$ |
| Input Noise Voltage Density | $E_N$ | $R_S$ = 20Ω, $f_O$ = 10Hz | 1 | +25°C | - | 10 | nV/√Hz |
| | | $R_S$ = 20Ω, $f_O$ = 100Hz | 1 | +25°C | - | 5.6 | nV/√Hz |
| | | $R_S$ = 20Ω, $f_O$ = 1kHz | 1 | +25°C | - | 4.5 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 10Hz | 1 | +25°C | - | 4.0 | pA/√Hz |
| | | $R_S$ = 2MΩ, $f_O$ = 100Hz | 1 | +25°C | - | 2.3 | pA/√Hz |
| | | $R_S$ = 2MΩ, $f_O$ = 1kHz | 1 | +25°C | - | 0.6 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_O$ = 100mV, $f_O$ = 10kHz | 1 | +25°C | 60 | - | MHz |
| | | $V_O$ = 100mV, $f_O$ = 1MHz | 1 | +25°C | 43 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 220 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | ±5 | - | V/V |
| Settling Time | $t_S$ | To 0.1% for a 10V Step | 1 | +25°C | - | 1.5 | µs |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 100 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 120 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on output.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

3

OPERATIONAL AMPLIFIERS

## Die Characteristics

**DIE DIMENSIONS:**
104.3 x 65 x 19 mils ± 1 mils
2650 x 1650 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.6 \times 10^5 A/cm^2$ at 15mA
This device meets Glassivation Integrity Test Requirement
per MIL-STD-883 Method 2021 and MIL-I-38535 Paragraph 30.5.5.4.

**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 63

**PROCESS:** Bipolar Dielectric Isolation

# HA-5142/883

July 1994

## Dual, Ultra Low Power Operational Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Supply Current at $V_S$ = +5V. . . .(+25°C) 160µA (Max) (Full) 200µA (Max)
- Wide Supply Voltage Range . . . . . .Single 3V to 30V or Dual ±1.5 to ±15V
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . . 0.8V/µs (Min) 1.5V/µs (Typ)
- High Gain . . . . . . . . . . . . . . . . . . . . . . . . . . 20kV/V (Min) 75kV/V (Typ)
- Low Noise (1kHz) . . . . . . . . . . . . . . . . . . 20nV/√Hz (Typ)
- 100% Tested at ±15V and +5V, 0V Power Supplies
- Unity Gain Stable
- Dielectric Isolation

### Applications

- Portable Instruments
- Meter Amplifiers
- Telephone Headsets
- Microphone Amplifiers
- Instrumentation
- For Further Design Ideas See Application Note AN544

### Description

The HA-5142/883 dual, ultra-low power operational amplifier provides AC and DC performance characteristics similar to, or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. This amplifier is well suited to applications which require low power dissipation and good electrical characteristics.

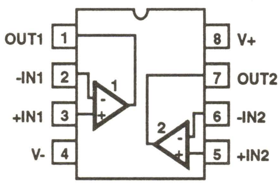
The HA-5142/883 provides accurate signal processing by virtue of their low input offset voltage (6mV), low input bias current (100nA), high open loop gain (20kV/V) and low noise (20nV/√Hz). These characteristics coupled with a 1.5V/µs slew rate and a 24kHz bandwidth make the HA-5142/883 ideal for use in low power instrumentation, audio amplifier and active filter designs.

### Ordering Information

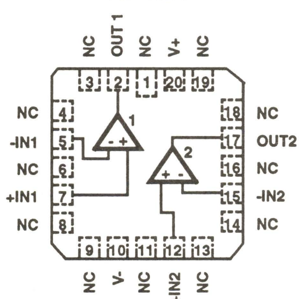
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA7-5142/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA2-5142/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5142/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

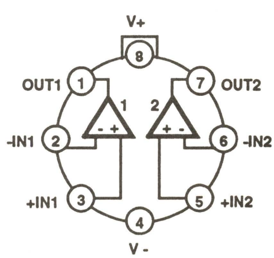
HA-5142/883 (CERDIP) TOP VIEW




HA-5142/883 (CLCC) TOP VIEW




HA-5142/883 (METAL CAN) TOP VIEW








Spec Number 511035-883
File Number 3732.1

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 35V
Differential Input Voltage.................................. 7V
Voltage at Either Input Terminal ...................... V+ to V-
Output Current .................. Full Short Circuit Protection
Output Current Duration ......................... Indefinite
One Amplifier Shorted to Ground
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................ -65°C to +150°C
ESD Rating......................................... <2000V
Lead Temperature (Soldering 10s)................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................. 870mW
Ceramic LCC Package .............................. 1.54W
Metal Can Package ............................... 645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ................................ 8.7mW/°C
Ceramic LCC Package ......................... 15.4mW/°C
Metal Can Package ............................. 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage....................... ±1.5V to ±15V
or 3V to 30V

$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq$ 50kΩ

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.
Subscript 1 Refers to Supply Voltages (V±) = ±15V, Subscript 2 Refers to V+ = 5.0, V- = 0V

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO1}$ | $V_{CM}$ = 0V | 1 | +25°C | -6 | 6 | µV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µV |
| | $V_{IO2}$ | $V_{CM}$ = 0V, $V_{OUT}$ = 1.4V | 1 | +25°C | -6 | 6 | µV |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | µV |
| Input Bias Current | $+I_{B1}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -100 | 100 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| | $-I_{B1}$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -100 | 100 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| | $+I_{B2}$ | $V_{CM}$ = 0V, $V_{OUT}$ = 1.4V, $+R_S$ = 10kΩ, $-R_S$ = 100Ω | 1 | +25°C | -100 | 100 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| | $-I_{B2}$ | $V_{CM}$ = 0V, $V_{OUT}$ = 1.4V, $+R_S$ = 100Ω, $-R_S$ = 10kΩ | 1 | +25°C | -100 | 100 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | nA |
| Input Offset Current | $I_{IO1}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -10 | 10 | nA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |
| | $I_{IO2}$ | $V_{CM}$ = 0V, $V_{OUT}$ = 1.4V $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -10 | 10 | nA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |
| Common Mode Range | $+CMR_1$ | V+ = +5V, V- = -25V | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-CMR_1$ | V+ = +25V, V- = -5V | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+CMR_2$ | V+ = +5V to +2V, V- = 0V to -3V, $V_{OUT}$ = 1.4V to -1.6V | 1 | +25°C | 3 | - | V |
| | | | 2, 3 | +125°C, -55°C | 3 | - | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $R_{SOURCE}$ = 100Ω, $R_{LOAD}$ = 500kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.
Subscript 1 Refers to Supply Voltages (V±) = ±15V, Subscript 2 Refers to V+ = 5.0, V- = 0V

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Large Signal Voltage Gain | $+A_{VOL1}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 50kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 15 | - | kV/V |
| | $-A_{VOL1}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 50kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 15 | - | kV/V |
| | $+A_{VOL2}$ | $V_{OUT}$ = 1.4V and 2.5V, $R_L$ = 50kΩ | 4 | +25°C | 20 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 15 | - | kV/V |
| Common Mode Rejection Ratio | $+CMRR_1$ | $\Delta V_{CM}$ = 10V, V+ = 5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| | $-CMRR_1$ | $\Delta V_{CM}$ = 10V, V+ = 25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| | $+CMRR_2$ | $\Delta V_{CM}$ = 0V to 3V, V+ = 2V, V- = -3V, $V_{OUT}$ = -1.6V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 50kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 50kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | $+V_{OUT2}$ | $R_L$ = 50kΩ Terminated at 2.5V | 1 | +25°C | 3.8 | - | V |
| | | | 2, 3 | +125°C, -55°C | 3.5 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 50kΩ Terminated at 2.5V | 1 | +25°C | - | 1 | V |
| | | | 2, 3 | +125°C, -55°C | - | 1.2 | V |
| Quiescent Power Supply Current (Both Amplifiers) | $+I_{CC1}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 300 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 400 | µA |
| | $-I_{CC1}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -300 | - | µA |
| | | | 2, 3 | +125°C, -55°C | -400 | - | µA |
| | $-I_{CC2}$ | $V_{OUT}$ = 1.4V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 160 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 200 | µA |
| Power Supply Rejection Ratio | $+PSRR_1$ | $\Delta V_{SUP}$ = +10V, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| | $-PSRR_1$ | $\Delta V_{SUP}$ = +10V, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| | $-PSRR_2$ | $\Delta V_{SUP}$ = +10V, V+ = +5V, V- = 0V, V+ = +15V, V- = 0V | 1 | +25°C | 77 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 77 | - | dB |
| Channel Separation | CS | $R_L$ = 50kΩ | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 50k\Omega$, $C_{LOAD} = 50pF$, $V_{OUT} = 0V$, $A_V = 1V/V$, Unless Otherwise Specified. Subscript 1 Refers to Supply Voltages ($V\pm$) = ±15V; Subscript 2 Refers to V+ = 5.0V, V- = 0.0V.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Slew Rate | $+SR_1$ | $V_{OUT}$ = -3V to +3V, $V_{IN}$ S.R. ≤ 10V/µs | 4 | +25°C | 0.8 | - | V/µs |
| | $-SR_1$ | $V_{OUT}$ = +3V to -3V, $V_{IN}$ S.R. ≤ 10V/µs | 4 | +25°C | 0.8 | - | V/µs |
| | $+SR_2$ | $V_{OUT}$ = 0V to +3V, $V_{IN}$ S.R. ≤ 10V/µs | 4 | +25°C | 0.8 | - | V/µs |
| | $-SR_2$ | $V_{OUT}$ = +3V to 0V, $V_{IN}$ S.R. ≤ 10V/µs | 4 | +25°C | 0.8 | - | V/µs |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 50k\Omega$, $C_{LOAD} = 50pF$, $A_V = 1V/V$, Unless Otherwise Specified. Subscript 1 Refers to Supply Voltages ($V\pm$) = ±15V; Subscript 2 Refers to V+ = 5.0V, V- = 0.0V.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Full Power Bandwidth | $FPBW_1$ | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 12.7 | - | kHz |
| | $FPBW_2$ | $V_{PEAK}$ = 1.1V, $V_{REF}$ = 2.5V | 1, 2 | +25°C | 115.8 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 50k\Omega$, $C_L$ = 50pF | 1 | -55°C to +125°C | 1 | - | V/V |
| Quiescent Power Consumption | $PC_1$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 12 | mW |
| | $PC_2$ | $V_{OUT}$ = 1.4V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 1 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
104 x 55 x 19 mils ± 1 mils
2650 x 1400 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.6 \times 10^5 A/cm^2$

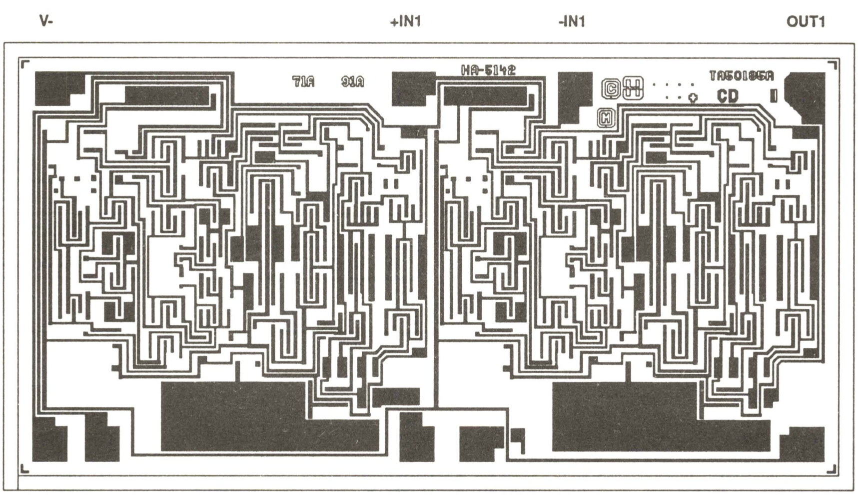
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 72

**PROCESS:** Bipolar/JFET Dielectric Isolation

## Metallization Mask Layout

HA-5142/883



HARRIS
SEMICONDUCTOR

# HA-5147/883

## Ultra Low Noise, Precision, High Slew Rate Wideband Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . . . 28V/µs (Min)
- Wide Gain Bandwidth ($A_V \geq 10$) . . . . . . . 100MHz (Min)
- Low Noise (at 1kHz). . . . . . . . . . . . . . . . 4.5nV/$\sqrt{Hz}$ (Max)
- Low Offset Voltage. . . . . . . . . . . . . . . . . . . . .100µV (Max)
- Low Offset Drift With Temperature. . . . 1.8µV/°C (Max)
- High CMRR. . . . . . . . . . . . . . . . . . . . . . . . . . .100dB (Min)
- High Voltage Gain . . . . . . . . . . . . . . . . . . . 700kV/V (Min)

### Applications

- High Speed Signal Conditioners
- Wide Bandwidth Instrumentation Amplifiers
- Low Level Transducer Amplifiers
- Fast, Low Level Voltage Comparators
- Highest Quality Audio Preamplifiers
- Pulse/RF Amplifiers

### Description

The HA-5147/883 monolithic operational amplifier features an unparalleled combination of precision DC and wideband high speed characteristics. Utilizing the Harris DI technology and advanced processing techniques, this unique design unites low noise precision instrumentation performance with high speed wideband capability.

This amplifier's impressive list of features include low $V_{OS}$, wide gain-bandwidth, high open loop gain, and high CMRR. Additionally, this flexible device operates over a wide supply range while consuming only 120mW of power.

Using the HA-5147/883 allows designers to minimize errors while maximizing speed and bandwidth in applications requiring gains greater than ten.

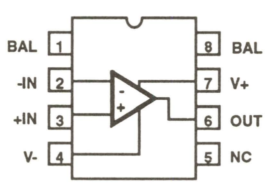
This device is ideally suited for low level transducer signal amplifier circuits. Other applications which can utilize the HA-5147/883's qualities include instrumentation amplifiers, pulse or RF amplifiers, audio preamplifiers, and signal conditioning circuits.

### Ordering Information

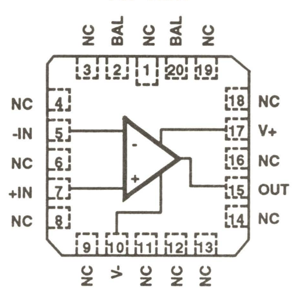
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5147/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5147/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5147/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

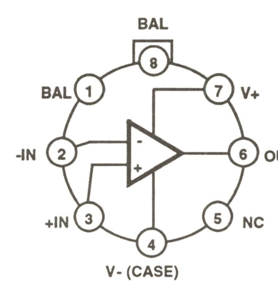
HA-5147/883
(CERDIP)
TOP VIEW




HA-5147/883
(CLCC)
TOP VIEW




HA-5147/883
(METAL CAN)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511009-883
File Number 3715

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 44V
Differential Input Voltage (Note 2) ......................... 0.7V
Voltage at Either Input Terminal ...................... V+ to V-
Input Current ........................................ 25mA
Differential Output Current .......... Full Short Circuit Protection
Junction Temperature ($T_J$) ......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating ........................................ <2000V
Lead Temperature (Soldering 10s) ..................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ................................ 870mW
Ceramic LCC Package ........................... 1.54W
Metal Can Package ............................. 645mW

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ................................ 8.7mW/°C
Ceramic LCC Package ........................... 15.4mW/°C
Metal Can Package ............................. 6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range ................ -55°C to +125°C
Operating Supply Voltage ............................ ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 600\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -100 | 100 | µV |
| | | | 2, 3 | +125°C, -55°C | -300 | 300 | µV |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V, $R_S$ = 10kΩ, 50Ω $\left(\frac{\lvert +I_B \rvert + \lvert -I_B \rvert}{2}\right)$ | 1 | +25°C | - | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | - | 150 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -135 | 135 | nA |
| Common Mode Range | +CMR | V+ = +4.7V, V- = -25.3V | 1 | +25°C | 10.3 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10.3 | - | V |
| | -CMR | V+ = +25.3V, V- = -4.7V | 1 | +25°C | - | -10.3 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10.3 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 700 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 300 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = +10V | 2, 3 | +125°C, -55°C | 100 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -11V | 1 | +25°C | 100 | - | dB |
| | | $\Delta V_{CM}$ = -10V | 2, 3 | +125°C, -55°C | 100 | - | dB |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | 11.5 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11.5 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -11.5 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11.5 | V |
| | $+V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | 10 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 16.5 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -16.5 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 4 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -4 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = +14V$ | 1 | +25°C | 86 | - | dB |
| | | $\Delta V_{SUP} = +13.5V$ | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP} = +14V$ | 1 | +25°C | 86 | - | dB |
| | | $\Delta V_{SUP} = +13.5V$ | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}-1$ | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}-1$ | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}+1$ | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}+1$ | - | mV |

NOTES:

1. Offset adjustment range is [$V_{IO}$ (Measured ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. For differential input voltages greater than 0.7V, the input current must be limited to 25mA to protect the back-to-back input diodes.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT} = -3V$ to $+3V$ | 7 | +25°C | 28 | - | V/µs |
| | -SR | $V_{OUT} = +3V$ to $-3V$ | 7 | +25°C | 28 | - | V/µs |
| Rise and Fall Time | $t_R$ | $V_{OUT} = 0$ to $+200mV$ $10\% \le T_R \le 90\%$ | 7 | +25°C | - | 50 | ns |
| | $t_F$ | $V_{OUT} = 0$ to $-200mV$ $10\% \le T_F \le 90\%$ | 7 | +25°C | - | 50 | ns |
| Overshoot | +OS | $V_{OUT} = 0$ to $+200mV$ | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT} = 0$ to $-200mV$ | 7 | +25°C | - | 40 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V = +10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM} = 0V$ | 1 | -55°C to +125°C | - | 1.8 | μV/°C |
| Differential Input Resistance | $R_{IN}$ | $V_{CM} = 0V$ | 1 | +25°C | 0.8 | - | MΩ |
| Low Frequency Peak-to-Peak Noise | $E_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 0.25 | $\mu V_{P-P}$ |
| Input Noise Voltage Density | $E_N$ | $R_S = 20\Omega$, $f_O = 10Hz$ | 1 | +25°C | - | 10 | nV/√Hz |
| | | $R_S = 20\Omega$, $f_O = 100Hz$ | 1 | +25°C | - | 5.6 | nV/√Hz |
| | | $R_S = 20\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 4.5 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S = 2M\Omega$, $f_O = 10Hz$ | 1 | +25°C | - | 4.0 | pA/√Hz |
| | | $R_S = 2M\Omega$, $f_O = 100Hz$ | 1 | +25°C | - | 2.3 | pA/√Hz |
| | | $R_S = 2M\Omega$, $f_O = 1kHz$ | 1 | +25°C | - | 0.6 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_O = 100mV$, $f_O = 10kHz$ | 1 | +25°C | 120 | - | MHz |
| | | $V_O = 100mV$, $f_O = 1MHz$ | 1 | +25°C | 100 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 445 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | ±10 | - | V/V |
| Settling Time | $t_S$ | To 0.1% for a 10V Step | 1 | +25°C | - | 600 | μs |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 100 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 120 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on output.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

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OPERATIONAL AMPLIFIERS

## *Die Characteristics*

**DIE DIMENSIONS:**
104.3 x 65 x 19 mils ± 1 mils
2650 x 1650 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.6 \times 10^5 A/cm^2$ at 15mA
This device meets Glassivation Integrity Test Requirement
per MIL-STD-883 Method 2021 and MIL-I-38535 Paragraph 30.5.5.4.

**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 63

**PROCESS:** Bipolar Dielectric Isolation

# HARRIS SEMICONDUCTOR

# HA-5177/883

July 1994

## Ultra Low Offset Voltage Operational Amplifier



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Offset Voltage . . . . . . . . . . . . . . . . . . . . . 60μV (Max) 10μV (Typ)**
- **Low Offset Voltage Drift . . . . . . . . . . . . 0.6μV/°C (Max) 0.1μV/°C (Typ)**
- **High Voltage Gain . . . . . . . . . . . . . . . . . . . . 126dB (Min) 150dB (Typ)**
- **High CMRR . . . . . . . . . . . . . . . . . . . . . . . . . 110dB (Min) 140dB (Typ)**
- **High PSRR . . . . . . . . . . . . . . . . . . . . . . . . . . 110dB (Min) 135dB (Typ)**
- **Low Noise . . . . . . . . . . . . . . . . . . . . . . . . 11nV/√Hz (Max) 9nV/√Hz (Typ)**
- **Low Power Consumption . . . . . . . . . . . . . 51mW (Max)**
- **Wide Gain Bandwidth Product . . . . . . . . . . 2MHz (Min)**
- **Unity Gain Stable**

### Applications

- **High Gain Instrumentation Amplifiers**
- **Precision Control Systems**
- **Precision Integrators**
- **High Resolution Data Converters**
- **Precision Threshold Detectors**
- **Low Level Transducer Amplifiers**

### Description

The HA-5177/883 is a monolithic, all bipolar, precision operational amplifier, utilizing Harris Dielectric Isolation and advance processing techniques. This design features a combination of precision input characteristics, wide gain bandwidth (2MHz) and high speed (0.5V/μs min) and is an improved version of the HA-5135/883.

The HA-5177/883 uses advanced matching techniques and laser trimming to produce low offset voltage (10μV typ, 60μV max) and low offset voltage drift (0.1μV/°C typ, 0.6μV/°C max). This design also features low voltage noise (9nV/√Hz typ), Low current noise (0.32pA/√Hz typ), nanoamp input currents, and 126dB minimum gain.

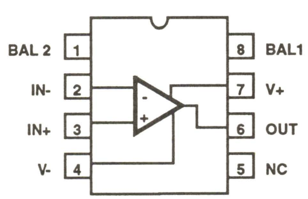
These outstanding features along with high CMRR (140dB typ, 110dB min) and high PSRR (135dB typ, 110dB min) make this unity gain stable amplifier ideal for high resolution data acquisition systems, precision integrators, and low level transducer amplifiers.

### Ordering Information

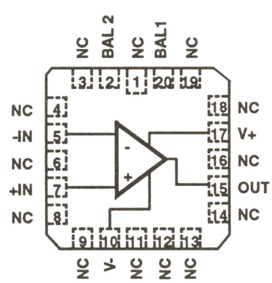
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5177/883 | -55°C to +125°C | 8 Pin Can |
| HA7-5177/883 | -55°C to +125°C | 8 Lead CerDIP |
| HA4-5177/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

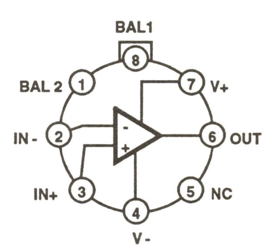
**HA-5177/883 (CERDIP)** TOP VIEW




**HA-5177/883 (CLCC)** TOP VIEW




**HA-5177/883 (METAL CAN)** TOP VIEW








Spec Number **511041-883**

File Number **3733.1**

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 44V
Differential Input Voltage (Note 1)........................ 7V
Voltage at Either Input Terminal ...................... V+ to V-
Input Current......................................25mA
Output Current .................... Full Short Circuit Protection
Junction Temperature ($T_J$) .......................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating....................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 28°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Metal Can Package | 155°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C for $T_J \leq$ +175°C
CerDIP Package ..............................870mW
Ceramic LCC Package ..........................1.54W
Metal Can Package ............................645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................8.7mW/°C
Ceramic LCC Package .......................15.4mW/°C
Metal Can Package ..........................6.5mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage ............................... ±15V
$V_{INCM} \leq$ 1/2 (V+ - V-)
$R_L \geq 600\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{SOURCE}$ = 50Ω, $R_{LOAD}$ = 100kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -60 | 60 | µV |
| | | | 2, 3 | +125°C, -55°C | -100 | 100 | µV |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V, $R_S$ = 10kΩ, 50Ω $\left(\frac{\lvert +I_B\rvert + \lvert -I_B\rvert}{2}\right)$ | 1 | +25°C | -6 | 6 | nA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 10kΩ, $-R_S$ = 10kΩ | 1 | +25°C | -6 | 6 | nA |
| | | | 2, 3 | +125°C, -55°C | -8 | 8 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V, $R_L$ = 2kΩ | 4 | +25°C | 126 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 120 | - | dB |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V, $R_L$ = 2kΩ | 4 | +25°C | 126 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 120 | - | dB |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = 10V, V+ = +5V, V- = - 25V, $V_{OUT}$ = -10 | 1 | +25°C | 116 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = 10V, V+ = +25V, V- = - 5V, $V_{OUT}$ = +10 | 1 | +25°C | 116 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| Output Voltage Swing | $+V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | 12 | - | V |
| | | | 5, 6 | +125°C, -55°C | 12 | - | V |
| | $-V_{OUT1}$ | $R_L$ = 2kΩ | 4 | +25°C | - | -12 | V |
| | | | 5, 6 | +125°C, -55°C | - | -12 | V |
| | $+V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | 10 | - | V |
| | $-V_{OUT2}$ | $R_L$ = 600Ω | 4 | +25°C | - | -10 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT} = -10V$ | 4 | +25°C | 15 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 15 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = +10V$ | 4 | +25°C | - | -15 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -15 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 1.7 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 1.7 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -1.7 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -1.7 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 15V$, V+ = +5V, V- = - 15V, V+ = +20V, V- = - 15V | 1 | +25°C | 110 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 15V$, V+ = +15V, V- = - 5V, V+ = +15V, V- = - 20V | 1 | +25°C | 110 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 2 | 1 | +25°C | 0.3 | - | mV |
| | | | 2, 3 | +125°C, -55°C | 0.3 | - | mV |
| | $-V_{IO}Adj$ | Note 2 | 1 | +25°C | - | -0.3 | mV |
| | | | 2, 3 | +125°C, -55°C | - | -0.3 | mV |

NOTES:

1. The input stage has series 500Ω resistors along with back to back diodes. This provides large differential input voltage protection for a slight increase in noise voltage.
2. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT} = -3V$ to $+3V$, $V_{IN}$ S.R. $\leq 25V/\mu s$ | 7 | +25°C | 0.5 | - | V/μs |
| | -SR | $V_{OUT} = +3V$ to $-3V$, $V_{IN}$ S.R. $\leq 25V/\mu s$ | 7 | +25°C | 0.5 | - | V/μs |
| Rise and Fall Time | $t_R$ | $V_{OUT} = 0$ to $+200mV$ $10\% \leq T_R \leq 90\%$ | 7 | +25°C | - | 420 | ns |
| | $t_F$ | $V_{OUT} = 0$ to $-200mV$ $10\% \leq T_F \leq 90\%$ | 7 | +25°C | - | 420 | ns |
| Overshoot | +OS | $V_{OUT} = 0$ to $+200mV$ | 7 | +25°C | - | 40 | % |
| | -OS | $V_{OUT} = 0$ to $-200mV$ | 7 | +25°C | - | 40 | % |

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OPERATIONAL AMPLIFIERS

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 2kΩ, $C_{LOAD}$ = 50pF, $A_V$ = +1V/V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Average Offset Voltage Drift | $V_{IO}TC$ | $V_{CM}$ = 0V | 1 | -55°C to +125°C | - | 0.6 | µV/°C |
| Average Offset Current Drift | $I_{IO}TC$ | Versus Temperature | 1 | -55°C to +125°C | - | 40 | pA/°C |
| Average Bias Current Drift | $I_BTC$ | Versus Temperature | 1 | -55°C to +125°C | - | 40 | pA/°C |
| Differential Input Resistance | $R_{IN}$ | $V_{CM}$ = 0V | 1 | +25°C | 20 | - | MΩ |
| Low Frequency Peak-to-Peak Noise Voltage | $E_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 0.6 | $\mu V_{P-P}$ |
| Low Frequency Peak-to-Peak Noise Current | $I_{NP-P}$ | 0.1Hz to 10Hz | 1 | +25°C | - | 45 | $pA_{P-P}$ |
| Input Noise Voltage Density | $E_N$ | $R_S$ = 20Ω, $f_O$ = 10Hz | 1 | +25°C | - | 18 | nV/√Hz |
| | | $R_S$ = 20Ω, $f_O$ = 100Hz | 1 | +25°C | - | 13 | nV/√Hz |
| | | $R_S$ = 20Ω, $f_O$ = 1kHz | 1 | +25°C | - | 11 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 2MΩ, $f_O$ = 10Hz | 1 | +25°C | - | 4 | pA/√Hz |
| | | $R_S$ = 2MΩ, $f_O$ = 100Hz | 1 | +25°C | - | 2.3 | pA/√Hz |
| | | $R_S$ = 2MΩ, $f_O$ = 1kHz | 1 | +25°C | - | 1 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_O$ = 100mV, 1Hz ≤ $f_O$ ≤ 100kHz | 1 | +25°C | 2 | - | MHz |
| Full Power Bandwidth | FPBW | $V_{PEAK}$ = 10V | 1, 2 | +25°C | 8 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L$ = 2kΩ, $C_L$ = 50pF | 1 | -55°C to +125°C | +1 | - | V/V |
| Settling Time | $t_S$ | To 0.1% for a 10V Step | 1 | +25°C | - | 15 | µs |
| Output Resistance | $R_{OUT}$ | Open Loop | 1 | +25°C | - | 70 | Ω |
| Power Consumption | PC | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1, 3 | -55°C to +125°C | - | 51 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6, 7 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

72 x 103 x 19 mils ± 1 mils

1840 x 2620 x 483µm ± 25.4µm

**METALLIZATION:**

Type: Al, 1% Cu

Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**

Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)

Silox Thickness: 12kÅ ± 2kÅ

Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**

$6.0 \times 10^4 A/cm^2$

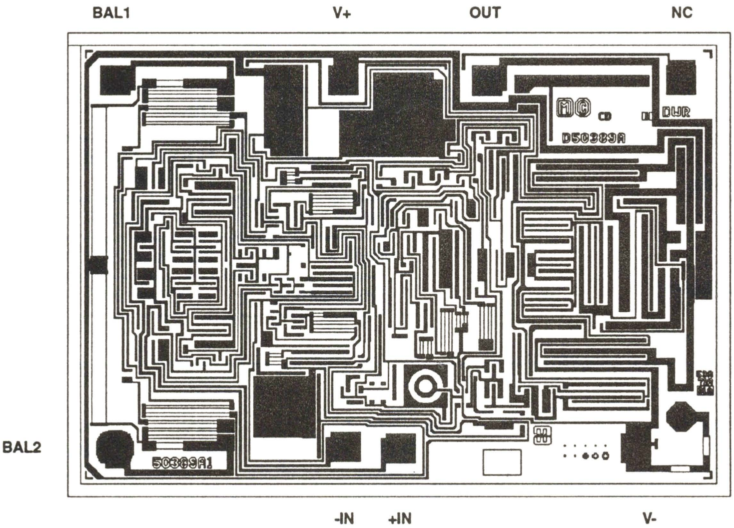
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 71

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5177/883



# HARRIS SEMICONDUCTOR

# HA-5221/883

## Low Noise, Wideband, Precision Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Gain Bandwidth Product . . . . . . . . . . . . . 100MHz (Min)
- Unity Gain Bandwidth . . . . . . . . . . . . . . . . 30MHz (Min) 40MHz (Typ)
- High Slew Rate . . . . . . . . . . . . . . . . . . . . . 25V/µs (Min) 37V/µs (Typ)
- Low Offset Voltage . . . . . . . . . . . . . . . . . . 0.75mV (Max) 0.30mV (Typ)
- High Open Loop Gain . . . . . . . . . . . . . . . . . 106dB (Min) 128dB (Typ)
- Low Voltage Noise (at 1kHz) . . . . . . . . . $5.8nV/\sqrt{Hz}$ (Max) $3.6nV/\sqrt{Hz}$ (Typ)
- Low Current Noise (at 1kHz) . . . . . . . . . $2.0pA/\sqrt{Hz}$ (Max) $1.4pA/\sqrt{Hz}$ (Typ)
- High Output Current . . . . . . . . . . . . . . . . . ±30mA (Min) ±56mA (Typ)
- Low Supply Current . . . . . . . . . . . . . . . . . . 10mA (Max) 8mA (Typ)

### Applications

- Precision Test Systems
- Active Filtering
- Small Signal Video
- Accurate Signal Processing
- RF Signal Conditioning

### Description

The HA-5221/883 is a high performance, dielectrically isolated, monolithic op amp, featuring precision DC characteristics while providing excellent AC characteristics. Designed for audio, video, and other demanding applications, noise ($3.6nV/\sqrt{Hz}$ at 1kHz typ), total harmonic distortion (<0.005% typ), and DC errors are kept to a minimum.

The precision performance is shown by low offset voltage (0.3mV typ), low bias currents (40nA typ), low offset currents (15nA typ), and high open loop gain (128dB typ). The combination of these excellent DC characteristics with fast settling time (0.4µs typ) make the HA-5221/883 ideally suited for precision signal conditioning.

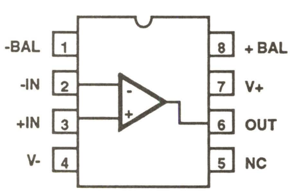
The unique design of the HA-5221/883 gives this device outstanding AC characteristics, including high unity gain bandwidth (40MHz typ) and high slew rate (37V/µs typ), not normally associated with precision op amps. Other key specifications include high CMRR (95dB typ) and high PSRR (100dB typ). The combination of these specifications will allow the HA-5221/883 to be used in RF signal conditioning as well as video amplifiers.

### Ordering Information

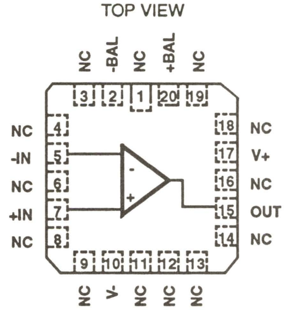
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA2-5221/883 | -55°C to +125°C | 8 Pin Can |
| HA4-5221/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5221/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

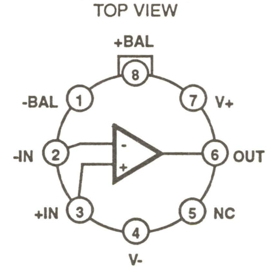
HA-5221/883 (CERDIP) TOP VIEW




HA-5221/883 (CLCC) TOP VIEW




HA-5221/883 (METAL CAN) TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511061-883
File Number 3716

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 36V
Differential Input Voltage.................................. 5V
Voltage at Either Input Terminal ..................... V+ to V-
Peak Output Current (Pulsed at 1ms, 10% Duty Cycle)..... 100mA
Continuous Output Current............... Short Circuit Protected
Junction Temperature............................... +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating........................................ <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 110°C/W | 27°C/W |
| Ceramic LCC Package | 64°C/W | 13°C/W |
| Metal Can Package | 148°C/W | 67°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package ................................ 0.91W
Ceramic LCC Package ........................... 1.56W
Metal Can Package ............................. 0.68W

Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................. 9.1mW/°C
Ceramic LCC Package ....................... 15.6mW/°C
Metal Can Package .......................... 6.8mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage......................... ±10V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -0.75 | 0.75 | mV |
| | | | 2, 3 | +125°C, -55°C | -1.5 | 1.5 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100Ω | 1 | +25°C | -80 | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100.1kΩ | 1 | +25°C | -80 | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100.1kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -150 | 150 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V | 4 | +25°C | 106 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 100 | - | dB |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V | 4 | +25°C | 106 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 100 | - | dB |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 88 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 88 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | 12.0 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11.5 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | - | -12.0 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11.5 | V |

Spec Number **511061-883**

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT} = +10V$, $R_L = 1k\Omega$ | 4 | +25°C | 30 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 30 | - | mA |
| | $-I_{OUT}$ | $V_{OUT} = -10V$, $R_L = 1k\Omega$ | 4 | +25°C | - | -30 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | 10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 11 | mA |
| | $-I_{CC}$ | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -11 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Offset Voltage Adjustment | $+V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$-1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$-1 | - | mV |
| | $-V_{IO}Adj$ | Note 1 | 1 | +25°C | $V_{IO}$+1 | - | mV |
| | | | 2, 3 | +125°C, -55°C | $V_{IO}$+1 | - | mV |

NOTE:

1. Offset adjustment range is [$V_{IO}$ (Measured ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC specifications in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Noise Voltage Density | $E_N$ | $R_S = 0\Omega$, $f_O = 10Hz$ | 1, 5 | +25°C | - | 24.0 | $nV/\sqrt{Hz}$ |
| | | $R_S = 0\Omega$, $f_O = 100Hz$ | 1, 5 | +25°C | - | 8.0 | $nV/\sqrt{Hz}$ |
| | | $R_S = 0\Omega$, $f_O = 1kHz$ | 1, 5 | +25°C | - | 5.8 | $nV/\sqrt{Hz}$ |
| Input Noise Current Density | $I_N$ | $R_S = 500k\Omega$, $f_O = 10Hz$ | 1, 5 | +25°C | - | 11.5 | $pA/\sqrt{Hz}$ |
| | | $R_S = 500k\Omega$, $f_O = 100Hz$ | 1, 5 | +25°C | - | 6.0 | $pA/\sqrt{Hz}$ |
| | | $R_S = 500k\Omega$, $f_O = 1kHz$ | 1, 5 | +25°C | - | 2.0 | $pA/\sqrt{Hz}$ |
| Gain Bandwidth Product | GBWP | $V_{OUT} = 200mV_{P-P}$, $f_O = 100kHz$ | 1 | +25°C | 100 | - | MHz |
| | | | | -55°C to +125°C | 90 | - | MHz |
| Unity Gain Bandwidth | UGBW | $V_{OUT} = 200mV$ | 1 | +25°C | 30 | - | MHz |
| | | | | -55°C to +125°C | 25 | - | MHz |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | ±SR | $V_{OUT} = \pm 2.5V$ $C_L = 50pF$ | 1 | -55°C to +125°C | 25 | - | V/µs |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | -55°C to +125°C | 398 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 1k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 1 | - | V/V |
| Rise and Fall Time | $t_R$, $t_F$ | $V_{OUT} = \pm 100mV$ | 1, 4 | +25°C | - | 20 | ns |
| Overshoot | ±OS | $V_{OUT} = \pm 100mV$ | 1 | +25°C | - | 25 | % |
| | | | | -55°C to +125°C | - | 30 | % |
| Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 660 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.
5. Input Noise Voltage Density and Input Noise Current Density limits are based on characterization data.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
72 x 94 x 19 mils ± 1 mils
1840 x 2400 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SIO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$4.2 \times 10^4 A/cm^2$

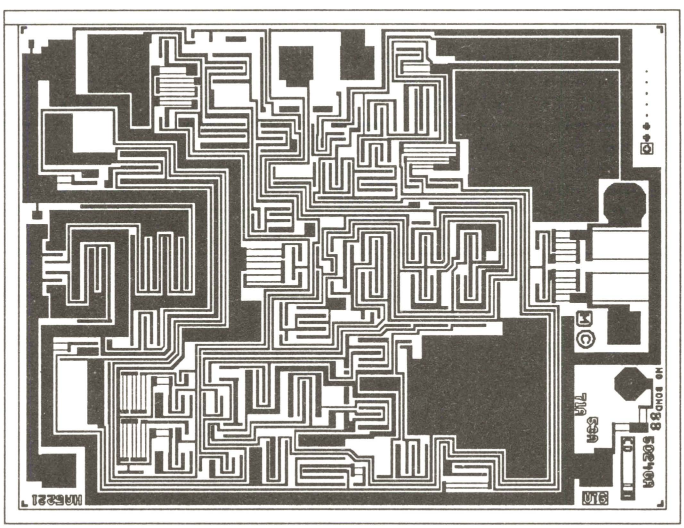
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 62

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5221/883



HARRIS SEMICONDUCTOR

# HA-5222/883

## Dual, Low Noise, Wideband, Precision Operational Amplifier

July 1994



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Gain Bandwidth Product ............. 100MHz (Min)**
- **Unity Gain Bandwidth ................ 30MHz (Min)**
  **40MHz (Typ)**
- **High Slew Rate ....................... 25V/µs (Min)**
  **37V/µs (Typ)**
- **Low Offset Voltage .................. 0.75mV (Max)**
  **0.30mV (Typ)**
- **High Open Loop Gain .................. 106dB (Min)**
  **128dB (Typ)**
- **Channel Separation (at 10kHz) .......... 110dB (Typ)**
- **Low Voltage Noise (at 1kHz) ........ 5.9nV/√Hz (Max)**
  **3.3nV/√Hz (Typ)**
- **Low Current Noise (at 1kHz) ........ 2.7pA/√Hz (Max)**
  **1.3pA/√Hz (Typ)**
- **High Output Current ................. ±30mA (Min)**
  **±56mA (Typ)**
- **Low Supply Current (per Op Amp.) ...... 10mA (Max)**
  **8mA (Typ)**

### Applications

- **Precision Test Systems**
- **Active Filtering**
- **Small Signal Video**
- **Accurate Signal Processing**
- **RF Signal Conditioning**

### Description

The HA-5222/883 is a dual, high performance, dielectrically isolated, monolithic op amp, featuring precision DC characteristics while providing excellent AC characteristics. Designed for audio, video, and other demanding applications, noise (3.3nV/√Hz at 1kHz typ), total harmonic distortion (<0.005% typ), and DC errors are kept to a minimum.

The precision performance is shown by low offset voltage (0.3mV typ), low bias currents (40nA typ), low offset currents (15nA typ), and high open loop gain (128dB typ). The combination of these excellent DC characteristics with fast settling time (0.4µs typ) make the HA-5222/883 ideally suited for precision signal conditioning.

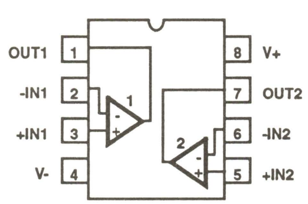
The unique design of the HA-5222/883 gives this device outstanding AC characteristics, including high unity gain bandwidth (40MHz typ) and high slew rate (37V/µs typ), not normally associated with precision op amps. Other key specifications include high CMRR (95dB typ) and high PSRR (100dB typ). The combination of these specifications will allow the HA-5222/883 to be used in RF signal conditioning as well as video amplifiers.

### Ordering Information

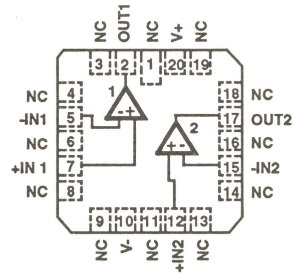
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA4-5222/883 | -55°C to +125°C | 20 Lead Ceramic LCC |
| HA7-5222/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinouts

**HA-5222/883**
**(CERDIP)**
TOP VIEW




**HA-5222/883**
**(CLCC)**
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 36V
Differential Input Voltage.................................. 5V
Voltage at Either Input Terminal ..................... V+ to V-
Peak Output Current (Pulsed at 1ms, 10% Duty Cycle)..... 100mA
Continuous Output Current.............. Short Circuit Protected
Junction Temperature.............................. +175°C
Storage Temperature Range ................. -65°C to +150°C
ESD Rating......................................... <2000V
Lead Temperature (Soldering 10s).................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 96°C/W | 16°C/W |
| Ceramic LCC Package | 55°C/W | 9°C/W |

Package Power Dissipation Limit at +75°C
CerDIP Package ................................. 1.04W
Ceramic LCC Package ........................... 1.82W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package ............................ 10.4mW/°C
Ceramic LCC Package ....................... 18.2mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range................ -55°C to +125°C
Operating Supply Voltage......................... ±5V to ±15V
$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 1k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -0.75 | 0.75 | mV |
| | | | 2, 3 | +125°C, -55°C | -1.5 | 1.5 | mV |
| Input Bias Current | $+I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100Ω | 1 | +25°C | -80 | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | nA |
| | $-I_B$ | $V_{CM}$ = 0V, $+R_S$ = 100Ω, $-R_S$ = 100.1kΩ | 1 | +25°C | -80 | 80 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | nA |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V, $+R_S$ = 100.1kΩ, $-R_S$ = 100.1kΩ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -150 | 150 | nA |
| Common Mode Range | +CMR | V+ = +3V, V- = -27V | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| | -CMR | V+ = +27V, V- = -3V | 1 | +25°C | - | -12 | V |
| | | | 2, 3 | +125°C, -55°C | - | -12 | V |
| Large Signal Voltage Gain | $+A_{VOL}$ | $V_{OUT}$ = 0V and +10V | 4 | +25°C | 106 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 100 | - | dB |
| | $-A_{VOL}$ | $V_{OUT}$ = 0V and -10V | 4 | +25°C | 106 | - | dB |
| | | | 5, 6 | +125°C, -55°C | 100 | - | dB |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM}$ = +10V, V+ = +5V, V- = -25V, $V_{OUT}$ = -10V | 1 | +25°C | 88 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | $\Delta V_{CM}$ = -10V, V+ = +25V, V- = -5V, $V_{OUT}$ = +10V | 1 | +25°C | 88 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | 12.0 | - | V |
| | | | 5, 6 | +125°C, -55°C | 11.5 | - | V |
| | $-V_{OUT}$ | $R_L$ = 1kΩ | 4 | +25°C | - | -12.0 | V |
| | | | 5, 6 | +125°C, -55°C | - | -11.5 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = +10V, $R_L$ = 1kΩ | 4 | +25°C | 30 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 30 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = -10V, $R_L$ = 1kΩ | 4 | +25°C | - | -30 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 20 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 22 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -20 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -22 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP}$ = 10V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP}$ = 10V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V | 1 | +25°C | 90 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTIC**

Device Characterized at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Noise Voltage Density | $E_N$ | $R_S$ = 0Ω, $f_O$ = 10Hz | 1, 5 | +25°C | - | 16.0 | nV/√Hz |
| | | $R_S$ = 0Ω, $f_O$ = 100Hz | 1, 5 | +25°C | - | 6.6 | nV/√Hz |
| | | $R_S$ = 0Ω, $f_O$ = 1kHz | 1, 5 | +25°C | - | 5.9 | nV/√Hz |
| Input Noise Current Density | $I_N$ | $R_S$ = 500kΩ, $f_O$ = 10Hz | 1, 5 | +25°C | - | 24.0 | pA/√Hz |
| | | $R_S$ = 500kΩ, $f_O$ = 100Hz | 1, 5 | +25°C | - | 6.6 | pA/√Hz |
| | | $R_S$ = 500kΩ, $f_O$ = 1kHz | 1, 5 | +25°C | - | 2.7 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_{OUT}$ = 200mV$_{P-P}$, $f_O$ = 100kHz | 1 | +25°C | 100 | - | MHz |
| | | | | -55°C to +125°C | 88 | - | MHz |
| Unity Gain Bandwidth | UGBW | $V_{OUT}$ = 200mV | 1 | +25°C | 30 | - | MHz |
| | | | | -55°C to +125°C | 25 | - | MHz |
| Slew Rate | ±SR | $V_{OUT}$ = ±2.5V, $C_L$ = 50pF | 1 | -55°C to +125°C | 25 | - | V/µs |

3

OPERATIONAL AMPLIFIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTIC (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | -55°C to +125°C | 398 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 1k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 1 | - | V/V |
| Rise and Fall Time | $t_R$, $t_F$ | $V_{OUT} = \pm100mV$ | 1, 4 | +25°C | - | 20 | ns |
| | | | | -55°C to +125°C | - | 35 | ns |
| Overshoot | ±OS | $V_{OUT} = \pm100mV$ | 1 | +25°C | - | 25 | % |
| | | | | -55°C to +125°C | - | 30 | % |
| Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 660 | mW |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
4. Measured between 10% and 90% points.
5. Input Noise Voltage Density and Input Noise Current Density limits are based on characterization data.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## *Die Characteristics*

**DIE DIMENSIONS:**
78 x 185 x 19 mils ± 1 mils
1980 x 4690 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SIO2 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$4.2 \times 10^4 A/cm^2$

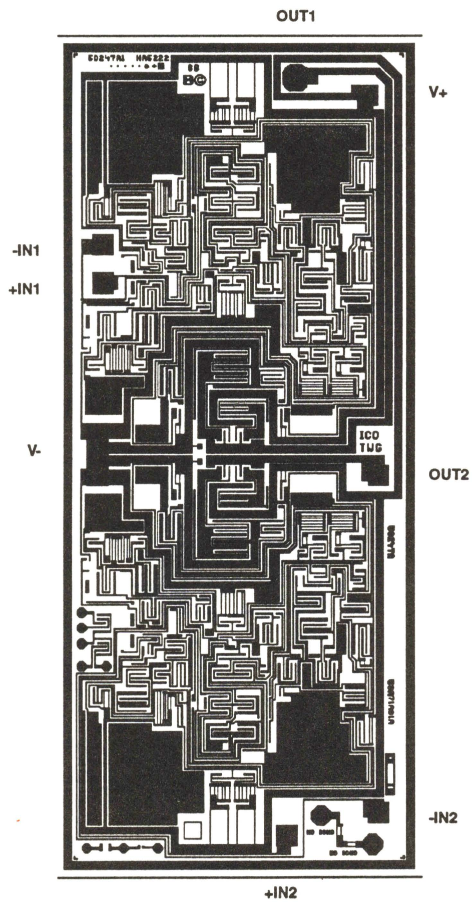
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 128

**PROCESS:** Bipolar Dielectric Isolation

## *Metallization Mask Layout*

HA-5222/883



# HARRIS SEMICONDUCTOR

# HFA1100/883

July 1994

## 850MHz Current Feedback Amplifier

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Distortion (HD3, 30MHz) . . . . . . . . . . -84dBc (Typ)
- Wide -3dB Bandwidth . . . . . . . . . . . . . . . 850MHz (Typ)
- Very High Slew Rate . . . . . . . . . . . . . . . 2300V/μs (Typ)
- Fast Settling (0.1%) . . . . . . . . . . . . . . . . . . . . 11ns (Typ)
- Excellent Gain Flatness (to 50MHz) . . . . . 0.05dB (Typ)
- High Output Current . . . . . . . . . . . . . . . . . . 65mA (Typ)
- Fast Overdrive Recovery. . . . . . . . . . . . . . . <10ns (Typ)

### Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems

### Description

The HFA1100/883 is a high speed, wideband, fast settling current feedback amplifier. Built with Harris' proprietary, complementary bipolar UHF-1 process, it is the fastest monolithic amplifier available from any semiconductor manufacturer.

The HFA1100/883's wide bandwidth, fast settling characteristic, and low output impedance, make this amplifier ideal for driving fast A/D converters.

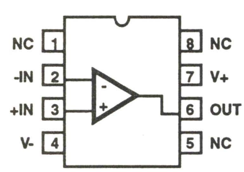
Component and composite video systems will also benefit from this amplifier's performance, as indicated by the excellent gain flatness, and 0.03%/0.05 Deg. Differential Gain/Phase specifications ($R_L = 75\Omega$).

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1100MJ/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinout

HFA1100/883
(CERDIP)
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . 12V
Differential Input Voltage . . . . . 5V
Voltage at Either Input Terminal . . . . . V+ to V-
Output Current (50% Duty Cycle) . . . . . ±55mA
Junction Temperature . . . . . +175°C
ESD Rating . . . . . < 2000V
Storage Temperature Range . . . . . $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) . . . . . ±5V
Operating Temperature Range . . . . . $-55^oC \le T_A \le +125^oC$
$R_L \ge 50\Omega$

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -6 | 6 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | 40 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 38 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -40 | 40 | µA |
| | | | 2, 3 | +125°C, -55°C | -65 | 65 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 40 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 50 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 1 | 1 | +25°C | 25 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | 1 | +25°C | -50 | 50 | µA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | µA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 7 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 10 | µA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | - | 15 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | µA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | - | 15 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | µA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω; $V_{IN}$ = -3.5V | 1 | +25°C | 3 | - | V |
| | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω; $V_{IN}$ = +3.5V | 1 | +25°C | - | -3 | V |
| | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.5 | V |

3
OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $V_{OP50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = -3V$ | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | | $V_{IN} = -2V$ | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = +3V$ | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | | $V_{IN} = +2V$ | 3 | -55°C | - | -1.5 | V |
| Output Current | $+I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | | 3 | -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | | 1 | +25°C | 14 | 26 | mA |
| | | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | | 1 | +25°C | -26 | -14 | mA |
| | | | | 2, 3 | +125°C, -55°C | -33 | - | mA |

NOTES:

1. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
2. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm 5V$, $A_V = +2$, $R_F = 360\Omega$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW(-1) | $A_V = -1$, $R_F = 430\Omega$ $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 300 | - | MHz |
| | BW(+1) | $A_V = +1$, $R_F = 510\Omega$ $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 550 | - | MHz |
| | BW(+2) | $A_V = +2$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 30MHz$ $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.04 | dB |
| | GF50 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 50MHz$ $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.10 | dB |
| | GF100 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 100MHz$ $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.30 | dB |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±5V, $A_V$ = +2, $R_F$ = 360Ω, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR(+1) | $A_V$ = +1, $R_F$ = 510Ω, $V_{OUT}$ = $5V_{P-P}$ | 1, 2 | +25°C | 1200 | - | V/µs |
| | -SR(+1) | $A_V$ = +1, $R_F$ = 510Ω, $V_{OUT}$ = $5V_{P-P}$ | 1, 2 | +25°C | 1100 | - | V/µs |
| | +SR(+2) | $A_V$ = +2, $V_{OUT}$ = $5V_{P-P}$ | 1, 2 | +25°C | 1650 | - | V/µs |
| | -SR(+2) | $A_V$ = +2, $V_{OUT}$ = $5V_{P-P}$ | 1, 2 | +25°C | 1500 | - | V/µs |
| Rise and Fall Time | $T_R$ | $A_V$ = +2, $V_{OUT}$ = $0.5V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| | $T_F$ | $A_V$ = +2, $V_{OUT}$ = $0.5V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| Overshoot | +OS | $A_V$ = +2, $V_{OUT}$ = $0.5V_{P-P}$ | 1, 3 | +25°C | - | 25 | % |
| | -OS | $A_V$ = +2, $V_{OUT}$ = $0.5V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| Settling Time | TS(0.1) | $A_V$ = +2, $R_F$ = 510Ω $V_{OUT}$ = 2V to 0V, to 0.1% | 1 | +25°C | - | 20 | ns |
| | TS(0.05) | $A_V$ = +2, $R_F$ = 510Ω $V_{OUT}$ = 2V to 0V, to 0.05% | 1 | +25°C | - | 33 | ns |
| 2nd Harmonic Distortion | HD2(30) | $A_V$ = +2, f = 30MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -48 | dBc |
| | HD2(50) | $A_V$ = +2, f = 50MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(100) | $A_V$ = +2, f = 100MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | $A_V$ = +2, f = 30MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | $A_V$ = +2, f = 50MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -60 | dBc |
| | HD3(100) | $A_V$ = +2, f = 100MHz, $V_{OUT}$ = $2V_{P-P}$ | 1 | +25°C | - | -40 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 200ps input transition times. Overshoot decreases as input transition times increase, especially for $A_V$ = +1. Please refer to Performance Curves.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
63 x 44 x 19 mils ± 1 mils
1600μm x 1130μm x 483μm ± 25.4μm

**METALLIZATION:**
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

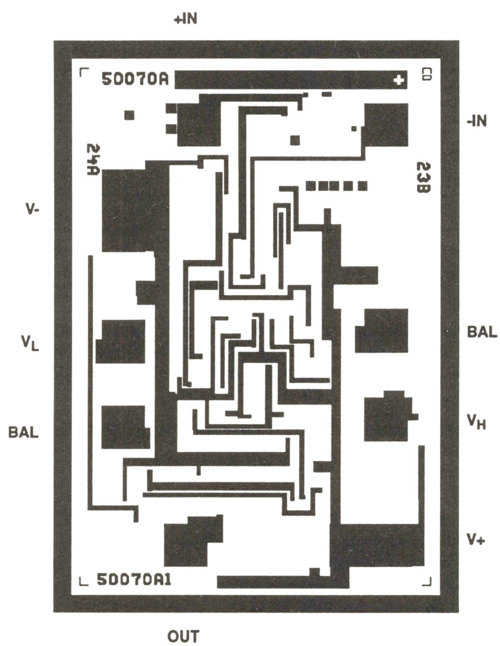
**WORST CASE CURRENT DENSITY:**
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1100/883



HARRIS SEMICONDUCTOR

# HFA1110/883

## 750MHz, Low Distortion Unity Gain, Closed Loop Buffer

June 1994

## Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Fixed Gain of +1
- Wide -3dB Bandwidth . . . . . . . . . . . . . . . 750MHz (Typ)
- Very Fast Slew Rate . . . . . . . . . . . . . . . . 1250V/µs (Typ)
- Low Differential Gain and Phase . . . 0.04%/0.025 Deg.
- Low Distortion (HD3, 30MHz) . . . . . . . . . . -80dBc (Typ)
- Excellent Gain Flatness (to 100MHz) . . . ±0.03dB (Typ)
- Excellent Gain Accuracy . . . . . . . . . . . . . . 0.99V/V (Typ)
- High Output Current . . . . . . . . . . . . . . . . . . 60mA (Typ)

## Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems

## Description

The HFA1110/883 is a unity gain, closed loop buffer which achieves a high degree of gain accuracy, wide bandwidth, and low distortion. Manufactured on Harris' proprietary complementary bipolar UHF-1 process, the HFA1110/883 also offers very fast slew rates, and high output current.

Component and composite video systems will also benefit from this buffer's performance, as indicated by the excellent gain flatness, and 0.04%/0.025 Degree Differential Gain/Phase specifications ($R_L = 75\Omega$).

For buffer applications desiring a standard op amp pinout, or selectable gain (-1, +1, +2), please refer to the HFA1112/883 and HFA1113/883 (featuring programmable output clamps) datasheets.

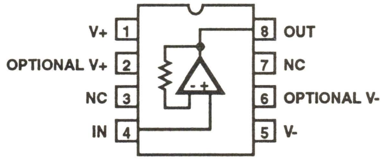
## Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1110MJ/883 | -55°C to +125°C | 8 Lead CerDIP |



## Pinout

HFA1110/883
(CERDIP)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 511083-883
File Number 3620.1

## Absolute Maximum Ratings

Voltage Between V+ and V- .......... 12V
Voltage at Input Terminal .......... V+ to V-
Output Current (50% Duty Cycle) .......... ±55mA
Junction Temperature .......... +175°C
ESD Rating .......... <2000V
Storage Temperature Range .......... $-65^{\circ}C \leq T_A \leq +150^{\circ}C$
Lead Temperature (Soldering 10s) .......... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package .......... 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package .......... 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$) .......... ±5V    $R_L \geq 50\Omega$
Operating Temperature Range .......... $-55^{\circ}C \leq T_A \leq +125^{\circ}C$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | 1 | +25°C | -25 | 25 | mV |
| | | | 2, 3 | +125°C, -55°C | -40 | 40 | mV |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | 39 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| | PSRRN | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | 39 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| Input Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -40 | 40 | μA |
| | | | 2, 3 | +125°C, -55°C | -65 | 65 | μA |
| Input Current Common Mode Rejection | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 40 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 50 | μA/V |
| Input Resistance | $R_{IN}$ | Note 1 | 1 | +25°C | 25 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Gain ($V_{OUT} = 2V_{P-P}$) | $A_{VP1}$ | $V_{IN}$ = -1V to +1V | 1 | +25°C | 0.980 | 1.020 | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $R_L = 100\Omega$, $V_{IN}$ = +3.3V | 1 | +25°C | 3 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $R_L = 100\Omega$, $V_{IN}$ = -3.3V | 1 | +25°C | - | -3 | V |
| | | | 2, 3 | +125°C, -55°C | - | -2.5 | V |
| Output Voltage Swing | $V_{OP50}$ | $R_L = 50\Omega$, $V_{IN}$ = +3.3V | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $R_L = 50\Omega$, $V_{IN}$ = -3.3V | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | | 3 | -55°C | - | -1.5 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | Note 2 | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | 3 | -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L$ = 100Ω | 1 | +25°C | 14 | 26 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L$ = 100Ω | 1 | +25°C | -26 | -14 | mA |
| | | | 2, 3 | +125°C, -55°C | -33 | - | mA |

NOTES:

1. Guaranteed from Input Common Mode Rejection Test, by: $R_{IN} = 1/CMS_{IBP}$
2. Guaranteed from $V_{OUT}$ Test with $R_L$ = 50Ω, by: $I_{OUT} = V_{OUT}/50Ω$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±5V, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW | $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | f ≤ 30MHz<br>$V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.025 | dB |
| | GF50 | f ≤ 50MHz<br>$V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.055 | dB |
| | GF100 | f ≤ 100MHz<br>$V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.08 | dB |
| Slew Rate | +SR | $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 800 | - | V/µs |
| | -SR | $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 800 | - | V/µs |
| Rise & Fall Time | $T_R$ | $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| | $T_F$ | $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| Overshoot | +OS | $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 30 | % |
| | -OS | $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 30 | % |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm5V$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| 2nd Harmonic Distortion | HD2(30) | f = 30MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -55 | dBc |
| | HD2(50) | f = 50MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(100) | f = 100MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | f = 30MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | f = 50MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -60 | dBc |
| | HD3(100) | f = 100MHz, $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -40 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 600ps input transition times. Overshoot decreases as input transition times increase, as shown in the Typical Performance Curve.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## *Die Characteristics*

**DIE DIMENSIONS:**

63 x 44 x 19 mils ± 1 mils
1600 x 1130 x 483μm ± 25.4μm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ±0.4kÅ

Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ±0.8kÅ

**GLASSIVATION:**

Type: Nitride
Thickness: 4kÅ ±0.5kÅ

**WORST CASE CURRENT DENSITY:**

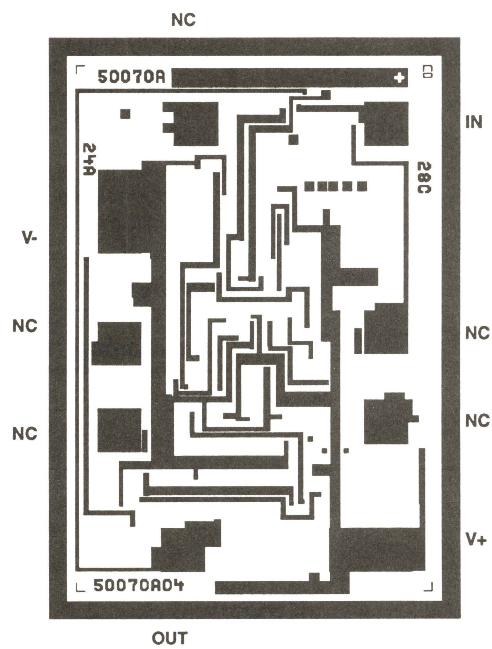
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## *Metallization Mask Layout*

**HFA1110/883**



HARRIS SEMICONDUCTOR

# HFA1112/883

## Ultra High Speed Programmable Gain Buffer Amplifier

June 1994

## Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- User Programmable For Closed-Loop Gains of +1, -1 or +2 Without Use of External Resistors
- Low Differential Gain and Phase .... 0.02%/0.04 Deg.
- Low Distortion (HD3, 30MHz) .......... -73dBc (Typ)
- Wide -3dB Bandwidth ............... 850MHz (Typ)
- Very High Slew Rate ............... 2400V/μs (Typ)
- Fast Settling (0.1%) .................... 13ns (Typ)
- Excellent Gain Flatness (to 100MHz).... 0.07dB (Typ)
- Excellent Gain Accuracy.............0.99V/V (Typ)
- High Output Current .................. 60mA (Typ)
- Fast Overdrive Recovery............... <10ns (Typ)

## Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems

## Description

The HFA1112/883 is a closed loop buffer that achieves a high degree of gain accuracy, wide bandwidth, and low distortion. Manufactured on the Harris proprietary complementary bipolar UHF-1 process, the HFA1112/883 also offers very fast slew rates, and high output current.

A unique feature of the pinout allows the user to select a voltage gain of +1, -1, or +2, without the use of any external components. The result is a more flexible product, fewer part types in inventory, and more efficient use of board space.

Component and composite video systems will also benefit from this buffer's performance, as indicated by the excellent gain flatness, and 0.02%/0.04 Deg. Differential Gain/Phase specifications ($R_L = 150\Omega$).

Compatibility with existing op amp pinouts provides flexibility to upgrade low gain amplifiers, while decreasing component count. Unlike most buffers, the standard pinout provides an upgrade path should a higher closed loop gain be needed at a future date.

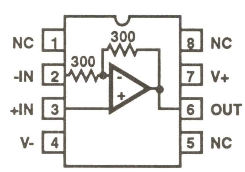
This amplifier is available with programmable output clamps as the HFA1113/883. For applications requiring a standard buffer pinout, please refer to the HFA1110/883 datasheet.

## Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1112MJ/883 | -55°C to +125°C | 8 Lead Ceramic DIP |

## Pinout

HFA1112/883
(CERDIP)
TOP VIEW








Spec Number **511084-883**
File Number **3610.1**

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12V
Differential Input Voltage. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5V
Voltage at Either Input Terminal . . . . . . . . . . . . . . . . . . . . . . V+ to V-
Output Current (50% Duty Cycle) . . . . . . . . . . . . . . . . . . . . . . . ±55mA
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . <2000V
Storage Temperature Range . . . . . . . . . . . . . . $-65°C \le T_A \le +150°C$
Lead Temperature (Soldering 10s). . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package . . . . . . . . . . . . . . . . . | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$). . . . . . . . . . . . . . . . . . . . . . . . . . . ±5V
Operating Temperature Range. . . . . . . . . . . . . $-55°C \le T_A \le +125°C$

$R_L \ge 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at $V_{SUPPLY}$ = ±5V, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| D.C. PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | 1 | +25°C | -25 | 25 | mV |
| | | | 2, 3 | +125°C, -55°C | -40 | 40 | mV |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | 39 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| | PSRRN | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | 39 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -40 | 40 | μA |
| | | | 2, 3 | +125°C, -55°C | -65 | 65 | μA |
| +IN Common Mode Rejection | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 40 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 50 | μA/V |
| +IN Resistance | $+R_{IN}$ | Note 1 | 1 | +25°C | 25 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Gain ($V_{OUT} = 2V_{P-P}$) | $A_{VP1}$ | $A_V$ = +1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | 0.980 | 1.020 | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| Gain ($V_{OUT} = 2V_{P-P}$) | $A_{VM1}$ | $A_V$ = -1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | 0.980 | 1.020 | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| Gain ($V_{OUT} = 4V_{P-P}$) | $A_{VP2}$ | $A_V$ = +2<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | 1.960 | 2.040 | V/V |
| | | | 2, 3 | +125°C, -55°C | 1.950 | 2.050 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = -2.7V | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = +3.2V | 1 | +25°C | - | -3 | V |
| | | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = +2.7V | 2, 3 | +125°C, -55°C | - | -2.5 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = -2.7V | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = -2.25V | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = +2.7V | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = +2.25V | 3 | -55°C | - | -1.5 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at $V_{SUPPLY}$ = ±5V, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| D.C. PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | Note 2 | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | 3 | -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L$ = 100Ω | 1 | +25°C | 14 | 26 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L$ = 100Ω | 1 | +25°C | -26 | -14 | mA |
| | | | 2, 3 | +125°C, -55°C | -33 | - | mA |

NOTES:

1. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$.
2. Guaranteed from $V_{OUT}$ Test with $R_L$ = 50Ω, by: $I_{OUT} = V_{OUT}/50Ω$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at $V_{SUPPLY}$ = ±5V, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW(-1) | $A_V$ = -1, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 450 | - | MHz |
| | BW(+1) | $A_V$ = +1, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 500 | - | MHz |
| | BW(+2) | $A_V$ = +2, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | $A_V$ = +2, f ≤ 30MHz $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.04 | dB |
| | GF50 | $A_V$ = +2, f ≤ 50MHz $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.08 | dB |
| | GF100 | $A_V$ = +2, f ≤ 100MHz $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.22 | dB |
| Slew Rate | +SR(-1) | $A_V$ = -1, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 1500 | - | V/µs |
| | -SR(-1) | $A_V$ = -1, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 1800 | - | V/µs |
| | +SR(+1) | $A_V$ = +1, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 900 | - | V/µs |
| | -SR(+1) | $A_V$ = +1, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 800 | - | V/µs |
| | +SR(+2) | $A_V$ = +2, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 1200 | - | V/µs |
| | -SR(+2) | $A_V$ = +2, $V_{OUT}$ = 5$V_{P-P}$ | 1, 2 | +25°C | 1100 | - | V/µs |
| Rise and Fall Time | $T_R$(-1) | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_F$(-1) | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 800 | ps |
| | $T_R$(+1) | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_F$(+1) | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_R$(+2) | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1000 | ps |
| | $T_F$(+2) | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1000 | ps |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at $V_{SUPPLY} = \pm 5V$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Overshoot | +OS(-1) | $A_V = -1$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 30 | % |
| | -OS(-1) | $A_V = -1$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 25 | % |
| | +OS(+1) | $A_V = +1$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 65 | % |
| | -OS(+1) | $A_V = +1$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 60 | % |
| | +OS(+2) | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| | -OS(+2) | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| Settling Time | TS(0.1) | $A_V = +2$, to 0.1%<br>$V_{OUT} = 2V$ to 0V | 1 | +25°C | - | 20 | ns |
| | TS(0.05) | $A_V = +2$, to 0.05%<br>$V_{OUT} = 2V$ to 0V | 1 | +25°C | - | 33 | ns |
| 2nd Harmonic Distortion | HD2(30) | $A_V = +2$, f = 30MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(50) | $A_V = +2$, f = 50MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -40 | dBc |
| | HD2(100) | $A_V = +2$, f = 100MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | $A_V = +2$, f = 30MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | $A_V = +2$, f = 50MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -55 | dBc |
| | HD3(100) | $A_V = +2$, f = 100MHz<br>$V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -45 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 200ps input transition times. Overshoot decreases as input transition times increase, especially for $A_V = +1$. Please refer to Performance curves.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

63 x 44 x 19 mils ± 1 mils
1600µm x 1130µm x 483µm ± 25.4µm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ

Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**

Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

**WORST CASE CURRENT DENSITY:**

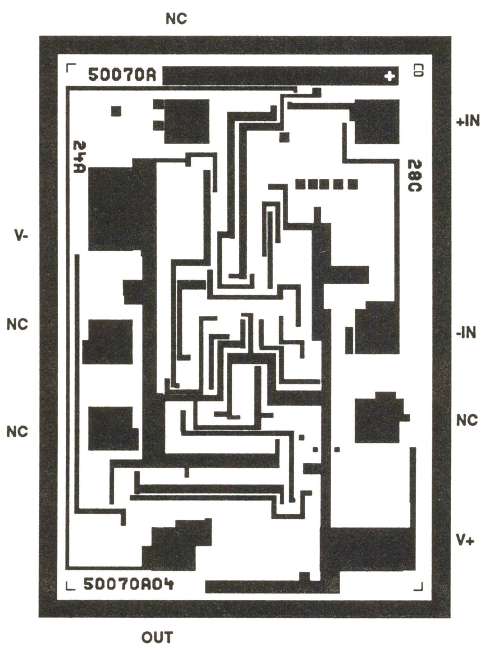
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1112/883



HARRIS SEMICONDUCTOR

# HFA1113/883

## Output Limiting, Ultra High Speed Programmable Gain, Buffer Amplifier

July 1994



### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- User Programmable Output Voltage Limiting
- User Programmable For Closed-Loop Gains of +1, -1 or +2 Without Use of External Resistors
- Low Differential Gain and Phase .... 0.02%/0.04 Deg.
- Low Distortion (HD3, 30MHz) .......... -73dBc (Typ)
- Wide -3dB Bandwidth ............... 850MHz (Typ)
- Very High Slew Rate ............... 2400V/µs (Typ)
- Fast Settling (0.1%) .................... 13ns (Typ)
- Excellent Gain Flatness (to 100MHz) .... 0.07dB (Typ)
- Excellent Gain Accuracy.............. 0.99V/V (Typ)
- High Output Current .................. 60mA (Typ)
- Fast Overdrive Recovery................ <1ns (Typ)

### Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems

### Description

The HFA1113/883 is a closed loop buffer featuring a high degree of gain accuracy, wide bandwidth, low distortion, and programmable output limiting. This buffer is the ideal choice for high frequency applications requiring output limiting, especially those needing ultra fast overdrive recovery times. The output limiting function allows the designer to set the maximum positive and negative output levels, thereby protecting later stages from damage or input saturation. The sub-nanosecond overdrive recovery time quickly returns the amplifier to linear operation following an overdrive condition.

Component and composite video systems will also benefit from this buffer's performance, as indicated by the excellent gain flatness, and 0.02%/0.04 Deg. Differential Gain/Phase specifications ($R_L = 150\Omega$).

A unique feature of the pinout allows the user to select a voltage gain of +1, -1, or +2, without the use of any external components, as described in the "Design Information" section. Compatibility with existing op amp pinouts provides flexibility to upgrade low gain amplifiers, while decreasing component count. Unlike most buffers, the standard pinout provides an upgrade path should a higher closed loop gain be needed at a future date.

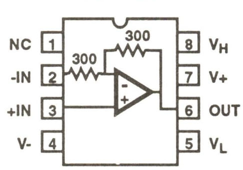
This amplifier is available without output limiting as the HFA1112/883. For applications requiring a standard buffer pinout, please refer to the HFA1110/883 datasheet.

### Ordering Information

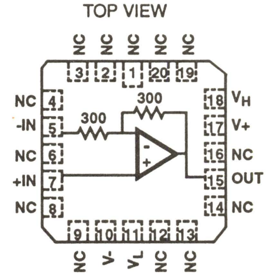
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1113MJ/883 | -55°C to +125°C | 8 Lead CerDIP |
| HFA1113ML/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

HFA1113/883
(CERDIP)
TOP VIEW




HFA1113/883
(CLCC)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511106-883**

File Number **3618.1**

## Absolute Maximum Ratings

Voltage Between V+ and V- .......... 12V
Differential Input Voltage.......... 5V
Voltage at Either Input Terminal .......... V+ to V-
Voltage at $V_H$ or $V_L$ Terminal.......... (V+) + 2V to (V-) - 2V
Output Current (50% Duty Cycle) .......... ±55mA
Junction Temperature .......... +175°C
ESD Rating.......... < 2000V
Storage Temperature Range .......... $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s).......... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package .......... 0.87W
Ceramic LCC Package .......... 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package .......... 8.7mW/°C
Ceramic LCC Package .......... 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$).......... ±5V    $R_L \ge 50\Omega$
Operating Temperature Range.......... $-55^oC \le T_A \le +125^oC$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | | 1 | +25°C | -25 | 25 | mV |
| | | | | 2, 3 | +125°C, -55°C | -40 | 40 | mV |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY}$ = ±1.25V, V+ = 6.25V, V- = -5V, V+ = 3.75V, V- = -5V | | 1 | +25°C | 39 | - | dB |
| | | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY}$ = ±1.25V, V+ = 5V, V- = -6.25V, V+ = 5V, V- = -3.75V | | 1 | +25°C | 39 | - | dB |
| | | | | 2, 3 | +125°C, -55°C | 35 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | | 1 | +25°C | -40 | 40 | µA |
| | | | | 2, 3 | +125°C, -55°C | -65 | 65 | µA |
| +IN Common Mode Rejection | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±2V, V+ = 3V, V- = -7V, V+ = 7V, V- = -3V | | 1 | +25°C | - | 40 | µA/V |
| | | | | 2, 3 | +125°C, -55°C | - | 50 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 1 | | 1 | +25°C | 25 | - | kΩ |
| | | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Gain ($V_{OUT}$ = $2V_{P-P}$) | $A_{VP1}$ | $A_V$ = +1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | 0.980 | 1.020 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| Gain ($V_{OUT}$ = $2V_{P-P}$) | $A_{VM1}$ | $A_V$ = -1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | 0.980 | 1.020 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| Gain ($V_{OUT}$ = $4V_{P-P}$) | $A_{VP2}$ | $A_V$ = +2, $V_{IN}$ = -1V to +1V | | 1 | +25°C | 1.960 | 2.040 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 1.950 | 2.050 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω | $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | | $V_{IN}$ = -2.7V | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω | $V_{IN}$ = +3.2V | 1 | +25°C | - | -3 | V |
| | | | $V_{IN}$ = +2.7V | 2, 3 | +125°C, -55°C | - | -2.5 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = -2.7V | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | | $V_{IN}$ = -2.25V | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = +2.7V | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | | $V_{IN}$=+2.25V | 3 | -55°C | - | -1.5 | V |
| Output Current | $+I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | | 3 | -55°C | - | -30 | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 5V$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | 1 | +25°C | 14 | 26 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | 1 | +25°C | -26 | -14 | mA |
| | | | 2, 3 | +125°C, -55°C | -33 | - | mA |
| Limiting Accuracy | $V_H$CLMP | $A_V = -1$, $V_{IN} = -1.6V$, $V_H = 1V$ | 1 | +25°C | -150 | 150 | mV |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | mV |
| | $V_L$CLMP | $A_V = -1$, $V_{IN} = +1.6V$, $V_L = -1V$ | 1 | +25°C | -150 | 150 | mV |
| | | | 2, 3 | +125°C, -55°C | -200 | 200 | mV |
| $V_H$ or $V_L$ Input Current | $V_H$BIAS | $V_H = 1V$ | 1 | +25°C | - | 200 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 300 | µA |
| | $V_L$BIAS | $V_L = -1V$ | 1 | +25°C | -200 | - | µA |
| | | | 2, 3 | +125°C, -55°C | -300 | - | µA |

NOTES:

1. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$.
2. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm 5V$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW(-1) | $A_V = -1$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 450 | - | MHz |
| | BW(+1) | $A_V = +1$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 500 | - | MHz |
| | BW(+2) | $A_V = +2$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | $A_V = +2$, $f \leq 30MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.04 | dB |
| | GF50 | $A_V = +2$, $f \leq 50MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.08 | dB |
| | GF100 | $A_V = +2$, $f \leq 100MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.22 | dB |
| Slew Rate | +SR(-1) | $A_V = -1$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1500 | - | V/µs |
| | -SR(-1) | $A_V = -1$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1800 | - | V/µs |
| | +SR(+1) | $A_V = +1$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 900 | - | V/µs |
| | -SR(+1) | $A_V = +1$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 800 | - | V/µs |
| | +SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1200 | - | V/µs |
| | -SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1100 | - | V/µs |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: $V_{SUPPLY}$ = ±5V, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Rise and Fall Time | $T_R(-1)$ | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_F(-1)$ | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 800 | ps |
| | $T_R(+1)$ | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_F(+1)$ | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 750 | ps |
| | $T_R(+2)$ | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1000 | ps |
| | $T_F(+2)$ | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1000 | ps |
| Overshoot | +OS(-1) | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 30 | % |
| | -OS(-1) | $A_V$ = -1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 25 | % |
| | +OS(+1) | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 65 | % |
| | -OS(+1) | $A_V$ = +1, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 60 | % |
| | +OS(+2) | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| | -OS(+2) | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| Settling Time | TS(0.1) | $A_V$ = +2, to 0.1%, $V_{OUT}$ = 2V to 0V | 1 | +25°C | - | 20 | ns |
| | TS(0.05) | $A_V$ = +2, to 0.05%, $V_{OUT}$ = 2V to 0V | 1 | +25°C | - | 33 | ns |
| 2nd Harmonic Distortion | HD2(30) | $A_V$ = +2, f = 30MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(50) | $A_V$ = +2, f = 50MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -40 | dBc |
| | HD2(100) | $A_V$ = +2, f = 100MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | $A_V$ = +2, f = 30MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | $A_V$ = +2, f = 50MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -55 | dBc |
| | HD3(100) | $A_V$ = +2, f = 100MHz, $V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -45 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 200ps input transition times. Overshoot decreases as input transition times increase, especially for $A_V$ = +1. Please refer to Performance Curves.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
63 x 44 x 19 mils ± 1 mils
1600 x 1130 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

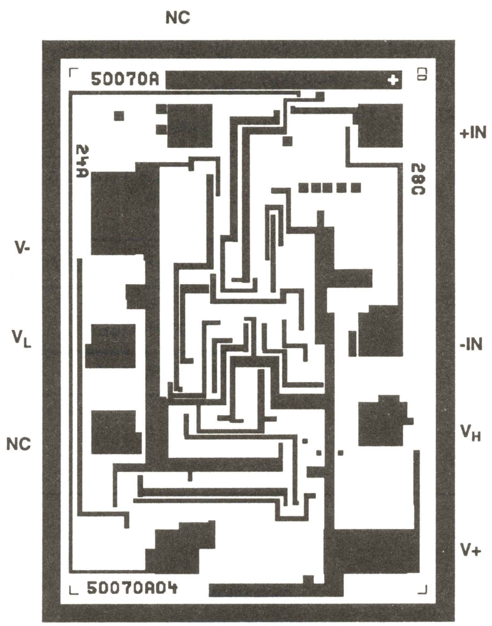
**WORST CASE CURRENT DENSITY:**
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1113/883



HARRIS SEMICONDUCTOR

# HFA1115/883

## High Speed, Low Power, Output Limiting Closed Loop Buffer Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- User Programmable Output Voltage Limiting
- User Programmable For Closed-Loop Gains of +1, -1 or +2 Without Use of External Resistors
- Standard Operational Amplifier Pinout
- Fast Overdrive Recovery . . . . . . . . . . . . . . . . <1ns (Typ)
- Low Supply Current . . . . . . . . . . . . . . . . . . 6.9mA (Typ)
- Excellent Gain Accuracy . . . . . . . . . . . . . . 0.99V/V (Typ)
- Wide -3dB Bandwidth . . . . . . . . . . . . . . . 225MHz (Typ)
- Fast Slew Rate . . . . . . . . . . . . . . . . . . . . 1135V/μs (Typ)
- High Input Impedance . . . . . . . . . . . . . . . . . . 1MΩ (Typ)
- Excellent Gain Flatness (to 50MHz) . . . . . ±0.1dB (Typ)

### Applications

- Flash A/D Driver
- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Medical Imaging Systems

### Description

The HFA1115/883 is a high speed closed loop Buffer featuring both user programmable gain and output limiting. Manufactured in Harris' proprietary complementary bipolar UHF-1 process, the HFA1115/883 also offers a wide -3dB bandwidth of 225MHz, very fast slew rate, excellent gain flatness and high output current.

This buffer is the ideal choice for high frequency applications requiring output limiting, especially those needing ultra fast overload recovery times. The limiting function allows the designer to set the maximum positive and negative output levels, thereby protecting later stages from damage or input saturation. The HFA1115/883 also allows for voltage gains of +2, +1, and -1, without the use of external resistors. Gain selection is accomplished via connections to the inputs, as described in the "Application Information" text. The result is a more flexible product, fewer part types in inventory, and more efficient use of board space.

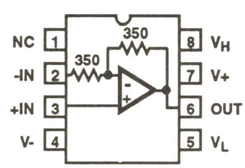
Compatibility with existing op amp pinouts provides flexibility to upgrade low gain amplifiers, while decreasing component count. Unlike most buffers, the standard pinout provides an upgrade path should a higher closed loop gain be needed at a future date.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1115MJ/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinout

HFA1115/883
(CERDIP)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . 12V
Voltage at Either Input Terminal . . . . . V+ to V-
Output Current (Note 1) . . . . . Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) . . . . . 60mA
Junction Temperature . . . . . +175°C
ESD Rating . . . . . > 2000V
Storage Temperature Range . . . . . $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package . . . . . | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) . . . . . ±5V
Operating Temperature Range . . . . . $-55^oC \le T_A \le +125^oC$
$R_L \ge 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | 1 | +25°C | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 42 | - | dB |
| | | | 2 | +125°C | 39 | - | dB |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 39 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 1.25 | µA/V |
| | | | 2 | +125°C | - | 2.85 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 2.85 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 2 | 1 | +25°C | 800 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |

3

OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Gain | $A_{VP1}$ | $A_V = +1$, $V_{IN} = -1V$ to $+1V$ | | 1 | +25°C | 0.98 | 1.02 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| | $A_{VM1}$ | $A_V = -1$, $V_{IN} = -1V$ to $+1V$ | | 1 | +25°C | -0.98 | -1.02 | V/V |
| | | | | 2, 3 | +125°C, -55°C | -0.975 | -1.025 | V/V |
| | $A_{VP2}$ | $A_V = +2$, $V_{IN} = -1V$ to $+1V$ | | 1 | +25°C | 1.96 | 2.04 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 1.95 | 2.05 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V = -1$, $R_L = 100\Omega$ | $V_{IN} = -3.2V$ | 1 | +25°C | 3 | - | V |
| | | | $V_{IN} = -3V$ | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V = -1$, $R_L = 100\Omega$ | $V_{IN} = +3.2V$ | 1 | +25°C | - | -3 | V |
| | | | $V_{IN} = +3V$ | 2, 3 | +125°C, -55°C | - | -2.8 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = -2.7V$ | 1 | +25°C | 2.5 | - | V |
| | | | $V_{IN} = -2.25V$ | 2 | +125°C | 2.0 | - | V |
| | | | $V_{IN} = -2.25V$ | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = +2.7V$ | 1 | +25°C | - | -2.5 | V |
| | | | $V_{IN} = +2.25V$ | 2 | +125°C | - | -2.0 | V |
| | | | $V_{IN} = +2.25V$ | 3 | -55°C | - | -1.4 | V |
| Output Current | $+I_{OUT}$ | Note 3 | | 1 | +25°C | 50 | - | mA |
| | | | | 2 | +125°C | 40 | - | mA |
| | | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | | 1 | +25°C | - | -50 | mA |
| | | | | 2 | +125°C | - | -40 | mA |
| | | | | 3 | -55°C | - | -28 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | | 1 | +25°C | 6.6 | 7.1 | mA |
| | | | | 2, 3 | +125°C, -55°C | 6.2 | 7.5 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | | 1 | +25°C | -7.1 | -6.6 | mA |
| | | | | 2, 3 | +125°C, -55°C | -7.5 | -6.2 | mA |
| Clamp Accuracy | $V_HCLMP$ | $A_V = -1$, $V_{IN} = -1.6V$, $V_H = 1V$ | | 1 | +25°C | -125 | 125 | mV |
| | | | | 2, 3 | +125°C, -55°C | -125 | 125 | mV |
| | $V_LCLMP$ | $A_V = -1$, $V_{IN} = +1.6V$, $V_L = -1V$ | | 1 | +25°C | -125 | 125 | mV |
| | | | | 2, 3 | +125°C, -55°C | -125 | 125 | mV |
| Clamp Input Current | $V_HBIAS$ | $V_H = 1V$ | | 1 | +25°C | - | 200 | µA |
| | | | | 2, 3 | +125°C, -55°C | - | 200 | µA |
| | $V_LBIAS$ | $V_L = -1V$ | | 1 | +25°C | -200 | - | µA |
| | | | | 2, 3 | +125°C, -55°C | -200 | - | µA |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

59 x 58.2 x 19 mils ± 1 mils
1500 x 1480 x 483μm ± 25.4μm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ

Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**

Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

**WORST CASE CURRENT DENSITY:**

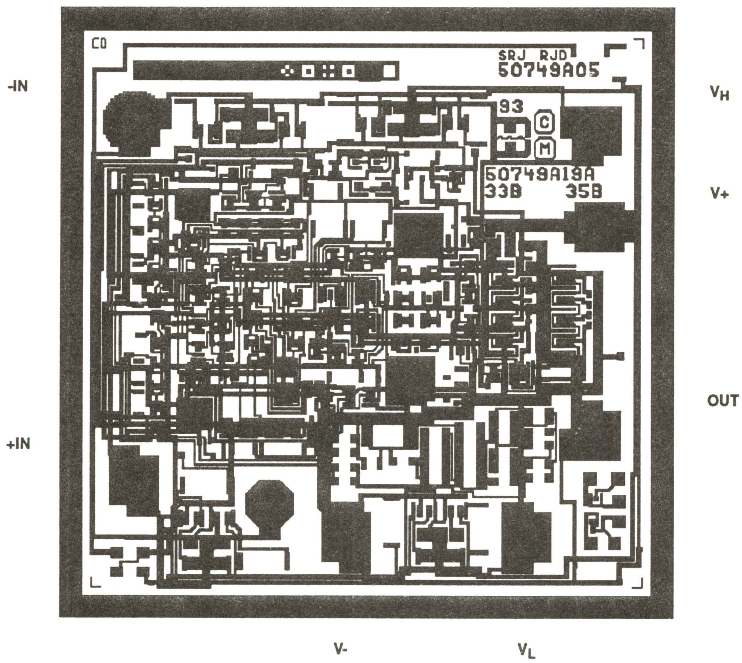
TBD

**TRANSISTOR COUNT:** 89

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

**HFA1115/883**



HARRIS SEMICONDUCTOR

# HFA1120/883

## 850MHz Current Feedback Amplifier with Offset Adjust

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Distortion (HD3, 30MHz) .......... -84dBc (Typ)
- Wide -3dB Bandwidth ............... 850MHz (Typ)
- Very High Slew Rate ............... 2300V/μs (Typ)
- Fast Settling (0.1%) .................... 11ns (Typ)
- Excellent Gain Flatness (to 50MHz) ..... 0.05dB (Typ)
- High Output Current .................. 65mA (Typ)
- Fast Overdrive Recovery............... <10ns (Typ)

### Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems

### Description

The HFA1120/883 is a high speed, wideband, fast settling current feedback amplifier. Built with Harris' proprietary, complementary bipolar UHF-1 process, it is the fastest monolithic amplifier available from any semiconductor manufacturer.

The HFA1120/883's wide bandwidth, fast settling characteristic, and low output impedance, make this amplifier ideal for driving fast A/D converters. Additionally, it offers offset voltage nulling capabilities as described in the "Offset Adjustment" section of this datasheet.

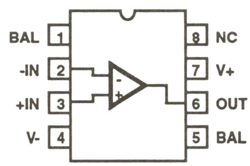
Component and composite video systems will also benefit from this amplifier's performance, as indicated by the excellent gain flatness, and 0.03%/0.05 Degree Differential Gain/Phase specifications ($R_L = 75\Omega$).

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1120MJ/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinout

HFA1120/883
(CERDIP)
TOP VIEW




3 OPERATIONAL AMPLIFIERS

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12V
Differential Input Voltage. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5V
Voltage at Either Input Terminal . . . . . . . . . . . . . . . . . . . . . . V+ to V-
Output Current (50% Duty Cycle) . . . . . . . . . . . . . . . . . . . . . . . ±55mA
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . <2000V
Storage Temperature Range . . . . . . . . . . . . . . $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) . . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$). . . . . . . . . . . . . . . . . . . . . . . . . . . ±5V
Operating Temperature Range . . . . . . . . . . . . . $-55^oC \le T_A \le +125^oC$
$R_L \ge 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -6 | 6 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm2V$<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | 40 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 38 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP} = \pm1.25V$<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUP} = \pm1.25V$<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -40 | 40 | µA |
| | | | 2, 3 | +125°C, -55°C | -65 | 65 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM} = \pm2V$<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 40 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 50 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 1 | 1 | +25°C | 25 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM} = 0V$ | 1 | +25°C | -50 | 50 | µA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | µA |
| -IN Current Adjust Range | $ADJ_{IBN}$ | $V_{CM} = 0V$, Note 3 | 1 | +25°C | 100 | -100 | µA |
| | | | 2, 3 | +125°C, -55°C | 100 | -100 | µA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM} = \pm2V$<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 7 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 10 | µA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUP} = \pm1.25V$<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | - | 15 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | µA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUP} = \pm1.25V$<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | - | 15 | µA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | µA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V = -1$, $R_L = 100\Omega$, $V_{IN} = -3.5V$ | 1 | +25°C | 3 | - | V |
| | | $V_{IN} = -3V$ | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $A_V = -1$, $R_L = 100\Omega$, $V_{IN} = +3.5V$ | 1 | +25°C | - | -3 | V |
| | | $V_{IN} = +3V$ | 2, 3 | +125°C, -55°C | - | -2.5 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm 5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $V_{OP50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = -3V$ | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | | $V_{IN} = -2V$ | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = +3V$ | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | | $V_{IN} = +2V$ | 3 | -55°C | - | -1.5 | V |
| Output Current | $+I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | | 3 | -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | | 1 | +25°C | 14 | 26 | mA |
| | | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | | 1 | +25°C | -26 | -14 | mA |
| | | | | 2, 3 | +125°C, -55°C | -33 | - | mA |

NOTES:

1. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$.
2. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.
3. This is the minimum change in inverting input bias current when a BAL pin is connected to V- through a 50Ω resistor.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY} = \pm 5V$, $A_V = +2$, $R_F = 360\Omega$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW(-1) | $A_V = -1$, $R_F = 430\Omega$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 300 | - | MHz |
| | BW(+1) | $A_V = +1$, $R_F = 510\Omega$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 550 | - | MHz |
| | BW(+2) | $A_V = +2$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 30MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.04 | dB |
| | GF50 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 50MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.10 | dB |
| | GF100 | $A_V = +2$, $R_F = 510\Omega$, $f \leq 100MHz$, $V_{OUT} = 200mV_{P-P}$ | 1 | +25°C | - | ±0.30 | dB |
| Slew Rate | +SR(+1) | $A_V = +1$, $R_F = 510\Omega$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1200 | - | V/µs |
| | -SR(+1) | $A_V = +1$, $R_F = 510\Omega$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1100 | - | V/µs |
| | +SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1650 | - | V/µs |
| | -SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1500 | - | V/µs |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY}$ = ±5V, $A_V$ = +2, $R_F$ = 360Ω, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Rise and Fall Time | $T_R$ | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| | $T_F$ | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| Overshoot | +OS | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 25 | % |
| | -OS | $A_V$ = +2, $V_{OUT}$ = 0.5$V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| Settling Time | TS(0.1) | $A_V$ = +2, $R_F$ = 510Ω<br>$V_{OUT}$ = 2V to 0V, to 0.1% | 1 | +25°C | - | 20 | ns |
| | TS(0.05) | $A_V$ = +2, $R_F$ = 510Ω<br>$V_{OUT}$ = 2V to 0V, to 0.05% | 1 | +25°C | - | 33 | ns |
| 2nd Harmonic Distortion | HD2(30) | $A_V$ = +2, f = 30MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -48 | dBc |
| | HD2(50) | $A_V$ = +2, f = 50MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(100) | $A_V$ = +2, f = 100MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | $A_V$ = +2, f = 30MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | $A_V$ = +2, f = 50MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -60 | dBc |
| | HD3(100) | $A_V$ = +2, f = 100MHz<br>$V_{OUT}$ = 2$V_{P-P}$ | 1 | +25°C | - | -40 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 200ps input transition times. Overshoot decreases as input transition times increase, especially for $A_V$ = +1. Please refer to Performance Curves.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

63 x 44 x 19 mils ± 1 mils
1600 x 1130 x 483µm ± 25.4µm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ

Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**

Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

**WORST CASE CURRENT DENSITY:**

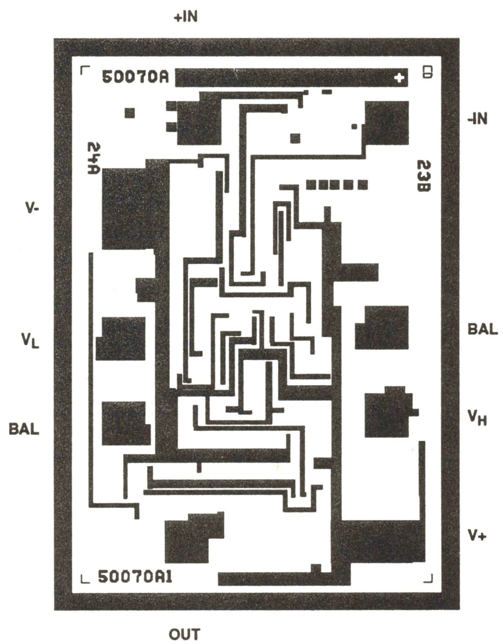
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1120/883



HARRIS
SEMICONDUCTOR

# HFA1130/883

## Output Clamping, 850MHz Current Feedback Amplifier

July 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **User Programmable Output Voltage Clamps**
- **Low Distortion (HD3, 30MHz) . . . . . . . . . . -84dBc (Typ)**
- **Wide -3dB Bandwidth . . . . . . . . . . . . . . . 850MHz (Typ)**
- **Very High Slew Rate . . . . . . . . . . . . . . . 2300V/μs (Typ)**
- **Fast Settling (0.1%) . . . . . . . . . . . . . . . . . . . . 11ns (Typ)**
- **Excellent Gain Flatness (to 50MHz) . . . . . 0.05dB (Typ)**
- **High Output Current . . . . . . . . . . . . . . . . . . 65mA (Typ)**
- **Fast Overdrive Recovery. . . . . . . . . . . . . . . . <1ns (Typ)**

### Applications

- **Residue Amplifier**
- **Video Switching and Routing**
- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **RF/IF Signal Processing**
- **Flash A/D Driver**
- **Medical Imaging Systems**

### Description

The HFA1130/883 is a high speed, wideband current feedback amplifier featuring programmable output clamps. Built with Harris' proprietary complementary bipolar UHF-1 process, it is the fastest monolithic amplifier available from any semiconductor manufacturer.

This amplifier is the ideal choice for high frequency applications requiring output limiting, especially those needing ultra fast overdrive recovery times. The output clamp function allows the designer to set the maximum positive and negative output levels, thereby protecting later stages from damage or input saturation. The sub-nanosecond overdrive recovery time quickly returns the amplifier to linear operation following an overdrive condition.

The HFA1130/883's wide bandwidth, fast settling characteristic, and low output impedance, coupled with the output clamping ability, make this amplifier ideal for driving fast A/D converters.

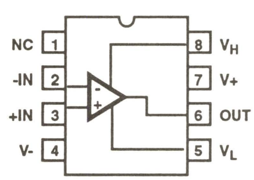
Component and composite video systems will also benefit from this amplifier's performance, as indicated by the excellent gain flatness, and 0.03%/0.05 Degree Differential Gain/Phase specifications ($R_L = 75\Omega$).

### Ordering Information

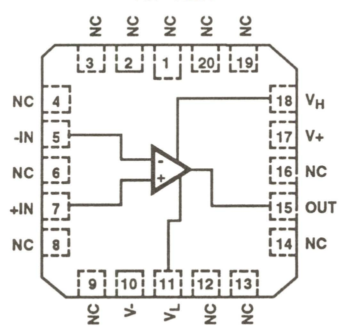
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1130MJ/883 | -55°C to +125°C | 8 Lead CerDIP |
| HFA1130ML/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

**HFA1130/883**
**(CERDIP)**
TOP VIEW




**HFA1130/883**
**(CLCC)**
TOP VIEW








Spec Number **511082-883**
File Number **3625.1**

## Absolute Maximum Ratings

Voltage Between V+ and V- .......... 12V
Differential Input Voltage .......... 5V
Voltage at Either Input Terminal .......... V+ to V-
Voltage at $V_H$ or $V_L$ Terminal .......... (V+) + 2V to (V-) - 2V
Output Current (50% Duty Cycle) .......... ±55mA
Junction Temperature .......... +175°C
ESD Rating .......... < 2000V
Storage Temperature Range .......... $-65^oC \leq T_A \leq +150^oC$
Lead Temperature (Soldering 10s) .......... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package .......... 0.87W
Ceramic LCC Package .......... 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package .......... 8.7mW/°C
Ceramic LCC Package .......... 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$) .......... ±5V
Operating Temperature Range .......... $-55^oC \leq T_A \leq +125^oC$
$R_L \geq 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -6 | 6 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | 40 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 38 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -40 | 40 | μA |
| | | | 2, 3 | +125°C, -55°C | -65 | 65 | μA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 40 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 50 | μA/V |
| +IN Resistance | $+R_{IN}$ | Note 1 | 1 | +25°C | 25 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 20 | - | kΩ |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | 1 | +25°C | -50 | 50 | μA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | μA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM}$ = ±2V<br>V+ = 3V, V- = -7V<br>V+ = 7V, V- = -3V | 1 | +25°C | - | 7 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 10 | μA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 6.25V, V- = -5V<br>V+ = 3.75V, V- = -5V | 1 | +25°C | - | 15 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | μA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUP}$ = ±1.25V<br>V+ = 5V, V- = -6.25V<br>V+ = 5V, V- = -3.75V | 1 | +25°C | - | 15 | μA/V |
| | | | 2, 3 | +125°C, -55°C | - | 27 | μA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = 3.5V | 1 | +25°C | 3 | - | V |
| | | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.5 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = +3.5V | 1 | +25°C | - | -3 | V |
| | | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.5 | V |

3

OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = -3V | 1, 2 | +25°C, +125°C | 2.5 | - | V |
| | | | $V_{IN}$ = -2V | 3 | -55°C | 1.5 | - | V |
| | $V_{ON50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = +3V | 1, 2 | +25°C, +125°C | - | -2.5 | V |
| | | | $V_{IN}$ = +2V | 3 | -55°C | - | -1.5 | V |
| Output Current | $+I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | 50 | - | mA |
| | | | | 3 | -55°C | 30 | - | mA |
| | $-I_{OUT}$ | Note 2 | | 1, 2 | +25°C, +125°C | - | -50 | mA |
| | | | | 3 | -55°C | - | -30 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L$ = 100Ω | | 1 | +25°C | 14 | 26 | mA |
| | | | | 2, 3 | +125°C, -55°C | - | 33 | mA |
| | $I_{EE}$ | $R_L$ = 100Ω | | 1 | +25°C | -26 | -14 | mA |
| | | | | 2, 3 | +125°C, -55°C | -33 | - | mA |
| Clamp Accuracy | $V_HCLMP$ | $A_V$ = -1, $V_{IN}$ = -2V, $V_H$ = 1V | | 1 | +25°C | -125 | 125 | mV |
| | | | | 2, 3 | +125°C, -55°C | -200 | 200 | mV |
| | $V_LCLMP$ | $A_V$ = -1, $V_{IN}$ = +2V, $V_L$ = -1V | | 1 | +25°C | -125 | 125 | mV |
| | | | | 2, 3 | +125°C, -55°C | -200 | 200 | mV |
| Clamp Input Current | $V_HBIAS$ | $V_H$ = 1V | | 1 | +25°C | - | 200 | µA |
| | | | | 2, 3 | +125°C, -55°C | - | 300 | µA |
| | $V_LBIAS$ | $V_L$ = -1V | | 1 | +25°C | -200 | - | µA |
| | | | | 2, 3 | +125°C, -55°C | -300 | - | µA |

NOTES:

1. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$.
2. Guaranteed from $V_{OUT}$ Test with $R_L$ = 50Ω, by: $I_{OUT} = V_{OUT}/50Ω$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: $V_{SUPPLY}$ = ±5V, $A_V$ = +2, $R_F$ = 360Ω, $R_L$ = 100Ω, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| -3dB Bandwidth | BW(-1) | $A_V$ = -1, $R_F$ = 430Ω, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 300 | - | MHz |
| | BW(+1) | $A_V$ = +1, $R_F$ = 510Ω, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 550 | - | MHz |
| | BW(+2) | $A_V$ = +2, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | 350 | - | MHz |
| Gain Flatness | GF30 | $A_V$ = +2, $R_F$ = 510Ω, f ≤ 30MHz, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.04 | dB |
| | GF50 | $A_V$ = +2, $R_F$ = 510Ω, f ≤ 50MHz, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.10 | dB |
| | GF100 | $A_V$ = +2, $R_F$ = 510Ω, f ≤ 100MHz, $V_{OUT}$ = 200m$V_{P-P}$ | 1 | +25°C | - | ±0.30 | dB |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at: $V_{SUPPLY} = \pm5V$, $A_V = +2$, $R_F = 360\Omega$, $R_L = 100\Omega$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR(+1) | $A_V = +1$, $R_F = 510\Omega$ $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1200 | - | V/µs |
| | -SR(+1) | $A_V = +1$, $R_F = 510\Omega$ $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1100 | - | V/µs |
| | +SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1650 | - | V/µs |
| | -SR(+2) | $A_V = +2$, $V_{OUT} = 5V_{P-P}$ | 1, 2 | +25°C | 1500 | - | V/µs |
| Rise and Fall Time | $T_R$ | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| | $T_F$ | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 2 | +25°C | - | 1 | ns |
| Overshoot | +OS | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 25 | % |
| | -OS | $A_V = +2$, $V_{OUT} = 0.5V_{P-P}$ | 1, 3 | +25°C | - | 20 | % |
| Settling Time | TS(0.1) | $A_V = +2$, $R_F = 510\Omega$ $V_{OUT} = 2V$ to 0V, to 0.1% | 1 | +25°C | - | 20 | ns |
| | TS(0.05) | $A_V = +2$, $R_F = 510\Omega$ $V_{OUT} = 2V$ to 0V, to 0.05% | 1 | +25°C | - | 33 | ns |
| 2nd Harmonic Distortion | HD2(30) | $A_V = +2$, f = 30MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -48 | dBc |
| | HD2(50) | $A_V = +2$, f = 50MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -45 | dBc |
| | HD2(100) | $A_V = +2$, f = 100MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -35 | dBc |
| 3rd Harmonic Distortion | HD3(30) | $A_V = +2$, f = 30MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -65 | dBc |
| | HD3(50) | $A_V = +2$, f = 50MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -60 | dBc |
| | HD3(100) | $A_V = +2$, f = 100MHz $V_{OUT} = 2V_{P-P}$ | 1 | +25°C | - | -40 | dBc |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot-to-lot and within lot variation.
2. Measured between 10% and 90% points.
3. For 200ps input transition times. Overshoot decreases as input transition times increase, especially for $A_V = +1$. Please refer to Performance Curves.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
63 x 44 x 19 mils ± 1 mils
1600 x 1130 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

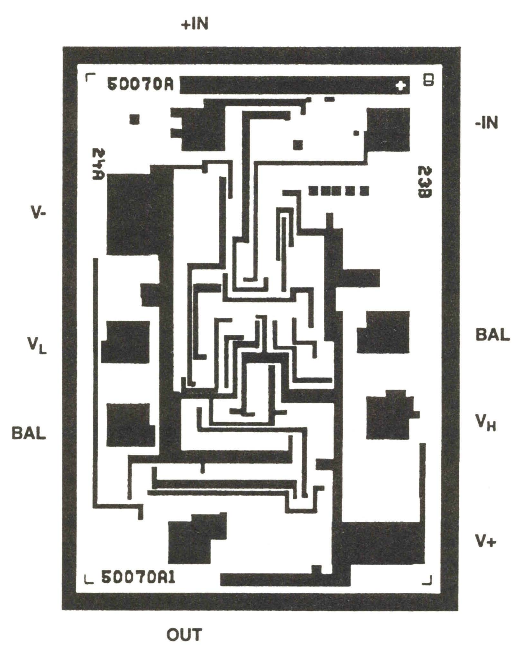
**WORST CASE CURRENT DENSITY:**
$2.0 \times 10^5$ A/cm$^2$ at 47.5mA

**TRANSISTOR COUNT:** 52

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1130/883




Spec Number **511082-883**

HARRIS SEMICONDUCTOR

# HFA1135/883

## High Speed, Low Power Current Feedback Amplifier with Programmable Output Limiting

June 1994



### Features

- **This Circuit Is Processed In Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **User Programmable Output Voltage Limiting**
- **Fast Overdrive Recovery . . . . . . . . . . . . . . . . <1ns (Typ)**
- **Low Supply Current . . . . . . . . . . . . . . . . . . 6.9mA (Typ)**
- **Wide -3dB Bandwidth . . . . . . . . . . . . . . . 360MHz (Typ)**
- **High Slew Rate . . . . . . . . . . . . . . . . . . . . 1200V/μs (Typ)**
- **High Input Impedance . . . . . . . . . . . . . . . . . . 2MΩ (Typ)**
- **Excellent Gain Flatness (to 50MHz) . . . . ±0.07dB (Typ)**

### Applications

- **Flash A/D Driver**
- **Video Switching and Routing**
- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **RF/IF Signal Processing**
- **Medical Imaging Systems**

### Description

The HFA1135/883 is a high speed, low power current feedback amplifier built with Harris' proprietary complementary bipolar UHF-1 process. This amplifier features user programmable output limiting, via the $V_H$ and $V_L$ pins.

The HFA1135/883 is the ideal choice for high speed, low power applications requiring output limiting (e.g. flash A/D drivers), especially those requiring fast overdrive recovery times. The limiting function allows the designer to set the maximum and minimum output levels to protect downstream stages from damage or input saturation. The sub-nanosecond overdrive recovery time ensures a quick return to linear operation following an overdrive condition.

Component and composite video systems also benefit from this op amp's performance, as indicated by the gain flatness, and differential gain and phase specifications.

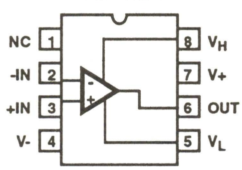
The HFA1135 is a low power, high performance upgrade for the CLC501 and CLC502.

### Ordering Information

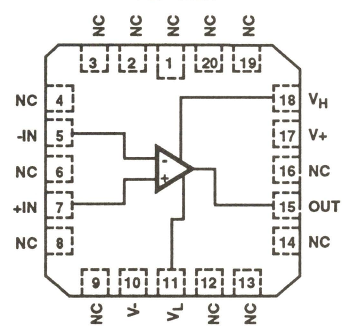
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1135MJ/883 | -55°C to +125°C | 8 Lead CerDIP |
| HFA1135ML/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Pinouts

**HFA1135/883**
**(CERDIP)**
TOP VIEW




**HFA1135/883**
**(CLCC)**
TOP VIEW








Spec Number 511115-883
File Number 3725

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . 12V
Differential Input Voltage. . . . . . . . . . 5V
Voltage at Either Input Terminal . . . . . . . . . . V+ to V-
Output Current (Note 1) . . . . . . . . . . Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) . . . . . . . . . . 60mA
Junction Temperature . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . > 2000V
Storage Temperature Range . . . . . . . . . . $-65^{\circ}C \leq T_A \leq +150^{\circ}C$
Lead Temperature (Soldering 10s). . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |
| Ceramic LCC Package | 75°C/W | 23°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . 0.87W
Ceramic LCC Package . . . . . . . . . . 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . 8.7mW/°C
Ceramic LCC Package . . . . . . . . . . 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$). . . . . . . . . . ±5V
Operating Temperature Range. . . . . . . . . . $-55^{\circ}C \leq T_A \leq +125^{\circ}C$
$R_L \geq 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -5 | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm1.8V$<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 47 | - | dB |
| | | | 2 | +125°C | 44 | - | dB |
| | | $\Delta V_{CM} = \pm1.2V$<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 44 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 50 | - | dB |
| | | | 2 | +125°C | 46 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 46 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 50 | - | dB |
| | | | 2 | +125°C | 46 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 46 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | μA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM} = \pm1.8V$<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 1.25 | μA/V |
| | | | 2 | +125°C | - | 2.85 | μA/V |
| | | $\Delta V_{CM} = \pm1.2V$<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 2.85 | μA/V |
| +IN Resistance | $+R_{IN}$ | Note 2 | 1 | +25°C | 800 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| +IN Current Power Supply Sensitivity | $PPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V; V+ = 6.8V, V- = -5V; V+ = 3.2V, V- = -5V | | 1 | +25°C | - | 1 | µA/V |
| | | | | 2 | +125°C | - | 3 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V; V+ = 6.2V, V- = -5V; V+ = 3.8V, V- = -5V | | 3 | -55°C | - | 3 | µA/V |
| | $NPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V; V+ = 5V, V- = -6.8V; V+ = 5V, V- = -3.2V | | 1 | +25°C | - | 1 | µA/V |
| | | | | 2 | +125°C | - | 3 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V; V+ = 5V, V- = -6.2V; V+ = 5V, V- = -3.8V | | 3 | -55°C | - | 3 | µA/V |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | | 1 | +25°C | -7.5 | 7.5 | µA |
| | | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM}$ = ±1.8V; V+ = 3.2V, V- = -6.8V; V+ = 6.8V, V- = -3.2V | | 1 | +25°C | - | 6 | µA/V |
| | | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V; V+ = 3.8V, V- = -6.2V; V+ = 6.2V, V- = -3.8V | | 3 | -55°C | - | 8 | µA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V; V+ = 6.8V, V- = -5V; V+ = 3.2V, V- = -5V | | 1 | +25°C | - | 5 | µA/V |
| | | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V; V+ = 6.2V, V- = -5V; V+ = 3.8V, V- = -5V | | 3 | -55°C | - | 8 | µA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V; V+ = 5V, V- = -6.8V; V+ = 5V, V- = -3.2V | | 1 | +25°C | - | 5 | µA/V |
| | | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V; V+ = 5V, V- = -6.2V; V+ = 5V, V- = -3.8V | | 3 | -55°C | - | 8 | µA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1; $R_L$ = 100Ω | $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V$ = -1; $R_L$ = 100Ω | $V_{IN}$=+3.2V | 1 | +25°C | - | -3 | V |
| | | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.8 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1; $R_L$ = 50Ω | $V_{IN}$ = -2.7V | 1 | +25°C | 2.5 | - | V |
| | | | $V_{IN}$ = -2.25V | 2 | +125°C | 2.0 | - | V |
| | | | $V_{IN}$ = -2.25V | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V$ = -1; $R_L$ = 50Ω | $V_{IN}$ = +2.7V | 1 | +25°C | - | -2.5 | V |
| | | | $V_{IN}$ = +2.25V | 2 | +125°C | - | -2.0 | V |
| | | | $V_{IN}$ = +2.25V | 3 | -55°C | - | -1.4 | V |
| Output Current | $+I_{OUT}$ | Note 3 | | 1 | +25°C | 50 | - | mA |
| | | | | 2 | +125°C | 40 | - | mA |
| | | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | | 1 | +25°C | - | -50 | mA |
| | | | | 2 | +125°C | - | -40 | mA |
| | | | | 3 | -55°C | - | -28 | mA |

3

OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | 1 | +25°C | 6.6 | 7.1 | mA |
| | | | 2, 3 | +125°C, -55°C | 6.2 | 7.5 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | 1 | +25°C | -7.1 | -6.6 | mA |
| | | | 2, 3 | +125°C, -55°C | -7.5 | -6.2 | mA |
| Clamp Accuracy | $V_HCLMP$ | $A_V = -1$, $V_{IN} = -2V$ $V_H = 1V$ | 1 | +25°C | -125 | 125 | mV |
| | | | 2, 3 | +125°C, -55°C | -150 | 150 | mV |
| | $V_LCLMP$ | $A_V = -1$, $V_{IN} = +2V$ $V_L = -1V$ | 1 | +25°C | -125 | 125 | mV |
| | | | 2, 3 | +125°C, -55°C | -150 | 150 | mV |
| Clamp Input Current | $V_HBIAS$ | $V_H = 1V$ | 1 | +25°C | - | 200 | μA |
| | | | 2, 3 | +125°C, -55°C | - | 200 | μA |
| | $V_LBIAS$ | $V_L = -1V$ | 1 | +25°C | -200 | - | μA |
| | | | 2, 3 | +125°C, -55°C | -200 | - | μA |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
59 x 58.2 x 19 mils ± 1 mils
1500 x 1480 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

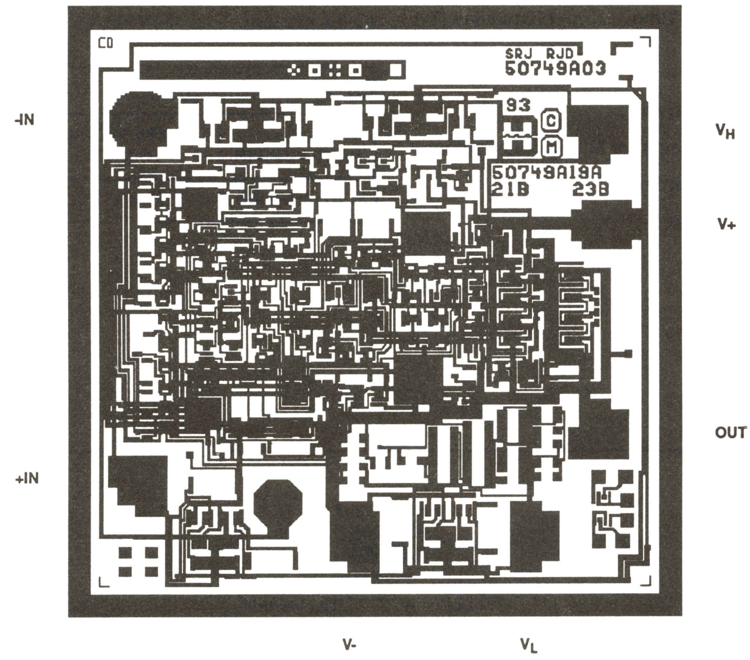
**WORST CASE CURRENT DENSITY:**
TBD

**TRANSISTOR COUNT:** 89

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

HFA1135/883



HARRIS SEMICONDUCTOR

# HFA1145/883

## High Speed, Low Power, Current Feedback Video Operational Amplifier with Output Disable

June 1994

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Supply Current . . . . . . . . . . . . . . . . . . 5.9mA (Typ)**
- **Wide -3dB Bandwidth . . . . . . . . . . . . . . . 360MHz (Typ)**
- **High Slew Rate . . . . . . . . . . . . . . . . . . . . 1000V/µs (Typ)**
- **Excellent Gain Flatness (to 50MHz) . . . . . ±0.07dB (Typ)**
- **Excellent Differential Gain . . . . . . . . . . . . . 0.02% (Typ)**
- **Excellent Differential Phase . . . . . . . . . 0.03 Deg. (Typ)**
- **High Output Current . . . . . . . . . . . . . . . . . . 60mA (Typ)**
- **Output Enable / Disable Time . . . . . . 180ns/35ns (Typ)**

### Applications

- **Multiplexed Flash A/D Driver**
- **RGB Multiplexers / Preamps for Multimedia Systems**
- **Video Switching and Routing**
- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **RF/IF Signal Processing**
- **Medical Imaging Systems**

### Description

The HFA1145/883 is a high speed, low power current feedback amplifier built with Harris' proprietary complementary bipolar UHF-1 process.

This amplifier features a TTL/CMOS compatible disable control, pin 8, which when pulled low, reduces the supply current and forces the output into a high impedance state. This allows easy implementation of simple, low power video switching and routing systems. Component and composite video systems also benefit from this op amp's excellent gain flatness, and good differential gain and phase specifications.

Multiplexed A/D applications will also find the HFA1145/883 useful as the A/D driver/multiplexer.

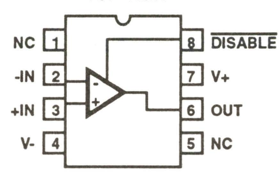
The HFA1145/883 is a low power, high performance upgrade for the CLC410.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1145MJ/883 | -55°C to +125°C | 8 Lead CerDIP |

### Pinout

**HFA1145/883**
**(CERDIP)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number **511116-883**
File Number **3726**

## Absolute Maximum Ratings

Voltage Between V+ and V- .......... 12V
Differential Input Voltage .......... 5V
Voltage at Either Input Terminal .......... V+ to V-
Output Current (Note 1) .......... Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) .......... 60mA
Junction Temperature .......... +175°C
ESD Rating .......... > 2000V
Storage Temperature Range .......... $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) .......... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package .......... 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package .......... 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) .......... ±5V
Operating Temperature Range .......... $-55^oC \le T_A \le +125^oC$
$R_L \ge 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM}$ = 0V | 1 | +25°C | -5 | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 47 | - | dB |
| | | | 2 | +125°C | 44 | - | dB |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 44 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 50 | - | dB |
| | | | 2 | +125°C | 46 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 46 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 50 | - | dB |
| | | | 2 | +125°C | 46 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 46 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 1.25 | µA/V |
| | | | 2 | +125°C | - | 2.85 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 2.85 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 2 | 1 | +25°C | 800 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |

3
OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 510Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| +IN Current Power Supply Sensitivity | $PPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | | 1 | +25°C | - | 1 | μA/V |
| | | | | 2 | +125°C | - | 3 | μA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | | 3 | -55°C | - | 3 | μA/V |
| | $NPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | | 1 | +25°C | - | 1 | μA/V |
| | | | | 2 | +125°C | - | 3 | μA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | | 3 | -55°C | - | 3 | μA/V |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | | 1 | +25°C | -7.5 | 7.5 | μA |
| | | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | | 1 | +25°C | - | 6 | μA/V |
| | | | | 2 | +125°C | - | 8 | μA/V |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | | 3 | -55°C | - | 8 | μA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | | 1 | +25°C | - | 5 | μA/V |
| | | | | 2 | +125°C | - | 8 | μA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | | 3 | -55°C | - | 8 | μA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | | 1 | +25°C | - | 5 | μA/V |
| | | | | 2 | +125°C | - | 8 | μA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | | 3 | -55°C | - | 8 | μA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1<br>$R_L$ = 100Ω | $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V$ = -1<br>$R_L$ = 100Ω | $V_{IN}$=+3.2V | 1 | +25°C | - | -3 | V |
| | | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.8 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1<br>$R_L$ = 50Ω | $V_{IN}$ = -2.7V | 1 | +25°C | 2.5 | - | V |
| | | | $V_{IN}$ = -2.25V | 2 | +125°C | 2.0 | - | V |
| | | | $V_{IN}$ = -2.25V | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V$ = -1<br>$R_L$ = 50Ω | $V_{IN}$ = +2.7V | 1 | +25°C | - | -2.5 | V |
| | | | $V_{IN}$ = +2.25V | 2 | +125°C | - | -2.0 | V |
| | | | $V_{IN}$ = +2.25V | 3 | -55°C | - | -1.4 | V |
| Output Current | $+I_{OUT}$ | Note 3 | | 1 | +25°C | 50 | - | mA |
| | | | | 2 | +125°C | 40 | - | mA |
| | | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | | 1 | +25°C | - | -50 | mA |
| | | | | 2 | +125°C | - | -40 | mA |
| | | | | 3 | -55°C | - | -28 | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 510\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | 1 | +25°C | 5.6 | 6.1 | mA |
| | | | 2, 3 | +125°C, -55°C | 5.2 | 6.5 | mA |
| | $I_{EE}$ | $R_L = 100\Omega$ | 1 | +25°C | -6.1 | -5.6 | mA |
| | | | 2, 3 | +125°C, -55°C | -6.5 | -5.2 | mA |
| Disabled Power Supply Current | $DISI_{CC}$ | $R_L = 100\Omega$, $V_{\overline{DIS}} = 0V$ | 1 | +25°C | - | 4 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 4 | mA |
| | $DISI_{EE}$ | $R_L = 100\Omega$, $V_{\overline{DIS}} = 0V$ | 1 | +25°C | -4 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -4 | - | mA |
| Disabled Output Leakage Current | DOLC | $V_{\overline{DIS}} = 0V$, $V_{IN} = \pm2.5V$, $V_{OUT} = \mp2.5V$ | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | µA |
| $\overline{\text{Disable}}$ Input Current | DILLC | $V_{\overline{DIS}} = 0V$ | 1 | +25°C | - | 200 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 200 | µA |
| | DILHC | $V_{\overline{DIS}} = 5V$ | 1 | +25°C | - | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 15 | µA |
| $\overline{\text{Disable}}$ Input Logic Levels | DILLV | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| | DILHV | | 1, 2 | +25°C, +125°C | 2.0 | - | V |
| | | | 3 | -55°C | 2.4 | - | V |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

59 x 58.2 x 19 mils ± 1 mils
1500 x 1480 x 483μm ± 25.4μm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ

Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**

Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

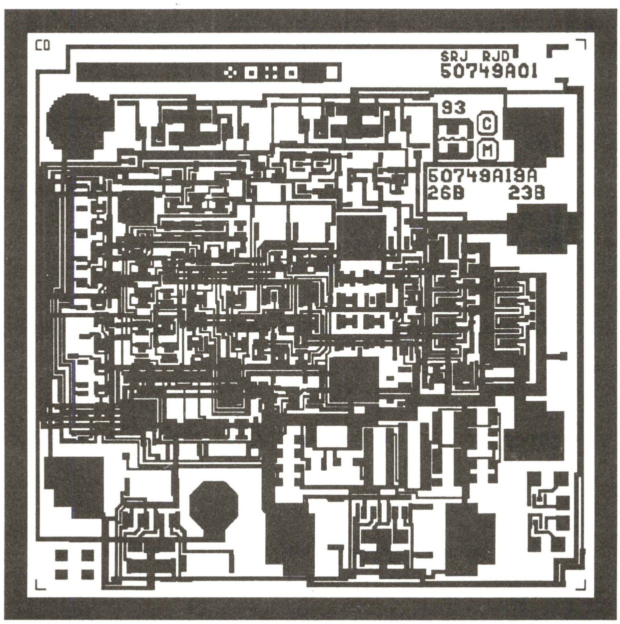
**WORST CASE CURRENT DENSITY:** TBD

**TRANSISTOR COUNT:** 75

## Metallization Mask Layout

**HFA1145/883**

-IN




V+

OUT

+IN

V-

OPTIONAL GND (NOTE)

NOTE: This pad is not bonded out on packaged units. Die users may set a GND reference, via this pad, to ensure the TTL compatibility of the $\overline{\text{DIS}}$ input when using asymmetrical supplies (e.g. V+ = 10V, V- = 0V).

Spec Number **511116-883**

HARRIS SEMICONDUCTOR

# HFA1212/883

**PRELIMINARY**

June 1994

## Dual, High Speed, Low Power, Video Closed Loop Buffer

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **User Programmable For Closed-Loop Gains of +1, -1 or +2 Without Use of External Resistors**
- **Standard Operational Amplifier Pinout**
- **Low Supply Current. . . . . . . . . . 5.9mA/Op Amp (Typ)**
- **Excellent Gain Accuracy. . . . . . . . . . . . . . 0.99V/V (Typ)**
- **Wide -3dB Bandwidth . . . . . . . . . . . . . . . 340MHz (Typ)**
- **Fast Slew Rate . . . . . . . . . . . . . . . . . . . . 1155V/μs (Typ)**
- **High Input Impedance . . . . . . . . . . . . . . . . . . 1MΩ (Typ)**
- **Excellent Gain Flatness (to 50MHz) . . . . ±0.02dB (Typ)**
- **Fast Overdrive Recovery. . . . . . . . . . . . . . . <10ns (Typ)**

### Applications

- **Flash A/D Driver**
- **Video Switching and Routing**
- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **RF/IF Signal Processing**
- **Medical Imaging Systems**

### Description

The HFA1212/883 is a dual closed loop Buffer featuring user programmable gain and high speed performance. Manufactured on Harris' proprietary complementary bipolar UHF-1 process, this device offers wide -3dB bandwidth of 340MHz, very fast slew rate, excellent gain flatness and high output current.

A unique feature of the pinout allows the user to select a voltage gain of +1, -1, or +2, without the use of any external components. Gain selection is accomplished via connections to the inputs, as described in the "Application Information" section. The result is a more flexible product, fewer part types in inventory, and more efficient use of board space.

Compatibility with existing op amp pinouts provides flexibility to upgrade low gain amplifiers, while decreasing component count. Unlike most buffers, the standard pinout provides an upgrade path should a higher closed loop gain be needed at a future date.

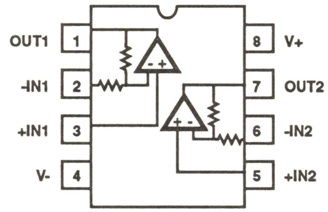
### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1212MJ/883 | -55°C to +125°C | 8 Lead CerDIP |



### Pinout

**HFA1212/883 (CERDIP)**
TOP VIEW








Spec Number 511111-883
File Number 3742

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12V
Voltage at Either Input Terminal . . . . . . . . . . . . . . . . . . . . . . . V+ to V-
Output Current (Note 1) . . . . . . . . . . . . . . . . Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) . . . . . . . . . . . . . . . . 60mA
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
ESD Rating . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . > 2000V
Storage Temperature Range . . . . . . . . . . . . . . $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) . . . . . . . . . . . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 115°C/W | 30°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0.87W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8.7mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ±5V    $R_L \ge 50\Omega$
Operating Temperature Range . . . . . . . . . . . . . $-55^oC \le T_A \le +125^oC$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM} = 0V$ | 1 | +25°C | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Channel-to-Channel Output Offset Voltage Mismatch | $\Delta V_{OS}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm1.8V$<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 42 | - | dB |
| | | | 2 | +125°C | 39 | - | dB |
| | | $\Delta V_{CM} = \pm1.2V$<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 39 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Channel-to-Channel +IN Current Mismatch | $\Delta I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±1.8V, V+ = 3.2V, V- = -6.8V, V+ = 6.8V, V- = -3.2V | | 1 | +25°C | - | 1.25 | µA/V |
| | | | | 2 | +125°C | - | 2.85 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V, V+ = 3.8V, V- = -6.2V, V+ = 6.2V, V- = -3.8V | | 3 | -55°C | - | 2.85 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 2 | | 1 | +25°C | 800 | - | kΩ |
| | | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |
| Gain | $A_{VP1}$ | $A_V$ = +1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | 0.98 | 1.02 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| | $A_{VM1}$ | $A_V$ = -1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | -0.98 | -1.02 | V/V |
| | | | | 2, 3 | +125°C, -55°C | -0.975 | -1.025 | V/V |
| | $A_{VP2}$ | $A_V$ = +2, $V_{IN}$ = -1V to +1V | | 1 | +25°C | 1.96 | 2.04 | V/V |
| | | | | 2, 3 | +125°C, -55°C | 1.95 | 2.05 | V/V |
| Channel-to-Channel Gain Mismatch | $\Delta A_{VP1}$ | $A_V$ = +1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | -0.02 | 0.02 | V/V |
| | | | | 2, 3 | +125°C, -55°C | -0.025 | 0.025 | V/V |
| | $\Delta A_{VM1}$ | $A_V$ = -1, $V_{IN}$ = -1V to +1V | | 1 | +25°C | -0.025 | 0.025 | V/V |
| | | | | 2, 3 | +125°C, -55°C | -0.025 | 0.025 | V/V |
| | $\Delta A_{VP2}$ | $A_V$ = +2, $V_{IN}$ = -1V to +1V | | 1 | +25°C | -0.04 | 0.04 | V/V |
| | | | | 2, 3 | +125°C, -55°C | -0.05 | 0.05 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω | $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω | $V_{IN}$=+3.2V | 1 | +25°C | - | -3 | V |
| | | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.8 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = -2.7V | 1 | +25°C | 2.5 | - | V |
| | | | $V_{IN}$ = -2.25V | 2 | +125°C | 2.0 | - | V |
| | | | $V_{IN}$ = -2.25V | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V$ = -1, $R_L$ = 50Ω | $V_{IN}$ = +2.7V | 1 | +25°C | - | -2.5 | V |
| | | | $V_{IN}$ = +2.25V | 2 | +125°C | - | -2.0 | V |
| | | | $V_{IN}$ = +2.25V | 3 | -55°C | - | -1.4 | V |

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OPERATIONAL AMPLIFIERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Current | $+I_{OUT}$ | Note 3 | 1 | +25°C | 50 | - | mA |
| | | | 2 | +125°C | 40 | - | mA |
| | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | 1 | +25°C | - | -50 | mA |
| | | | 2 | +125°C | - | -40 | mA |
| | | | 3 | -55°C | - | -28 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L$ = 100Ω | 1 | +25°C | 5.6 | 6.1 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | 5.2 | 6.5 | mA/Op Amp |
| | $I_{EE}$ | $R_L$ = 100Ω | 1 | +25°C | -6.1 | -5.6 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | -6.5 | -5.2 | mA/Op Amp |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L$ = 50Ω, by: $I_{OUT} = V_{OUT}/50Ω$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1(Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**

69 x 92 x 19 mils ± 1 mils

1750 x 2330 x 483µm ± 25.4µm

**METALLIZATION:**

Type: Metal 1: AlCu(2%)/TiW

Thickness: Metal 1: 8kÅ ± 0.4kÅ

Type: Metal 2: AlCu(2%)

Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**

Type: Nitride

Thickness: 4kÅ ± 0.5kÅ

**WORST CASE CURRENT DENSITY:**

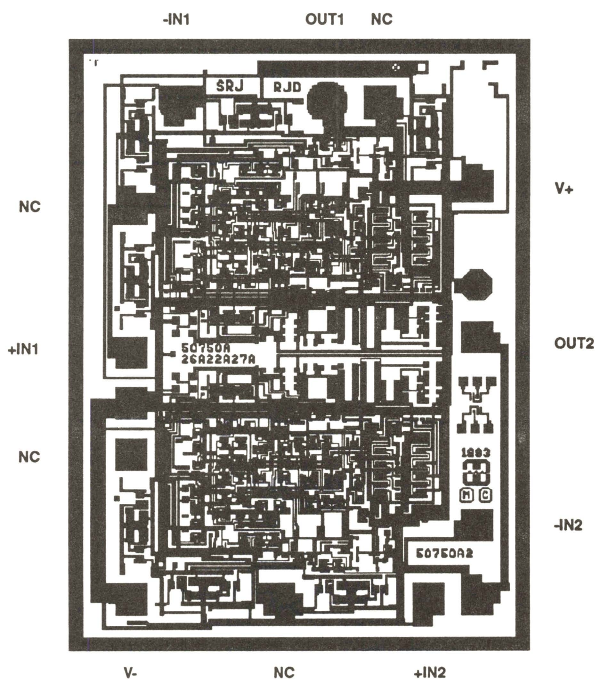
TBD

**TRANSISTOR COUNT:** 150

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

**HFA1212/883**



HARRIS SEMICONDUCTOR

# HFA1245/883

**PRELIMINARY**

June 1994

## Dual, High Speed, Low Power, Video Operational Amplifier with Output Disable

### *Features*

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Supply Current. . . . . . . . . . . . . . . . . . 5.9mA (Typ)**
- **Wide -3dB Bandwidth . . . . . . . . . . . . . . . 530MHz (Typ)**
- **High Slew Rate. . . . . . . . . . . . . . . . . . . . 1050V/μs (Typ)**
- **Excellent Gain Flatness (to 50MHz) . . . . ±0.11dB (Typ)**
- **Excellent Differential Gain . . . . . . . . . . . . . 0.02% (Typ)**
- **Excellent Differential Phase . . . . . . . . . 0.03 Deg. (Typ)**
- **High Output Current . . . . . . . . . . . . . . . . . . 60mA (Typ)**
- **Individual Output Enable/Disable**
- **Output Enable / Disable Time . . . . . . 160ns/20ns (Typ)**

### *Applications*

- **Multiplexed Flash A/D Driver**
- **RGB Multiplexers and Preamps**
- **Video Switching and Routing**
- **Pulse and Video Amplifiers**
- **Wideband Amplifiers**
- **Hand Held and Miniaturized RF Equipment**
- **Battery Powered Communications**

### *Description*

The HFA1245/883 is a dual high speed, low power current feedback amplifier built with Harris' proprietary complementary bipolar UHF-1 process.

This amplifier features individual TTL/CMOS compatible disable controls, which when pulled low, reduce the supply current and force the output into a high impedance state. This allows easy implementation of simple, low power video switching and routing systems. Component and composite video systems also benefit from this op amp's excellent gain flatness, and good differential gain and phase specifications.

Multiplexed A/D applications will also find the HFA1245/883 useful as the A/D driver/multiplexer.

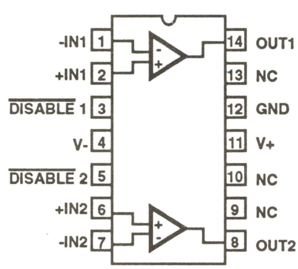
The HFA1245/883 is a low power, high performance upgrade for the popular HA5022/883.

### *Ordering Information*

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1245MJ/883 | -55°C to +125°C | 14 Lead CerDIP |

### *Pinout*

**HFA1245/883**
**(CERDIP)**
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . . . . . . 12V
Differential Input Voltage. . . . . . . . . . . . . . . 5V
Voltage at Either Input Terminal . . . . . . . . . . . V+ to V-
Output Current (Note 1) . . . . . . . . Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) . . . . . . . . 60mA
Junction Temperature . . . . . . . . . . . . . . +175°C
ESD Rating. . . . . . . . . . . . . . . . . > 2000V
Storage Temperature Range . . . . . . . . $-65^oC \le T_A \le +150^oC$
Lead Temperature (Soldering 10s) . . . . . . . . . +300°C

## Thermal Information

Thermal Resistance — $\theta_{JA}$ / $\theta_{JC}$
CerDIP Package . . . . . . . . 75°C/W 20°C/W
Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . . . . . 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . . . . . 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) . . . . . . . . . . . . . . ±5V
Operating Temperature Range . . . . . . . . $-55^oC \le T_A \le +125^oC$
$R_L \ge 50\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 560\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -5 | 5 | mV |
| | | | 2, 3 | +125°C, -55°C | -10 | 10 | mV |
| Channel-to-Channel Input Offset Voltage Mismatch | $\Delta V_{IO}$ | $V_{CM} = 0V$ | 1 | +25°C | -7.5 | 7.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -15 | 15 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM} = \pm1.8V$<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{CM} = \pm1.2V$<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 42 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 48 | - | dB |
| | | | 2 | +125°C | 45 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 45 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY} = \pm1.8V$<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 48 | - | dB |
| | | | 2 | +125°C | 45 | - | dB |
| | | $\Delta V_{SUPPLY} = \pm1.2V$<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 45 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | μA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| Channel-to-Channel +IN Current Mismatch | $\Delta I_{BSP}$ | $V_{CM} = 0V$ | 1 | +25°C | -15 | 15 | μA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM} = \pm1.8V$<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 1.25 | μA/V |
| | | | 2 | +125°C | - | 2.85 | μA/V |
| | | $\Delta V_{CM} = \pm1.2V$<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 2.85 | μA/V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_F$ = 560Ω, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| +IN Resistance | $+R_{IN}$ | Note 2 | 1 | +25°C | 800 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |
| +IN Current Power Supply Sensitivity | $PPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | - | 1 | µA/V |
| | | | 2 | +125°C | - | 3 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | - | 3 | µA/V |
| | $NPSS_{IBP}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | - | 1 | µA/V |
| | | | 2 | +125°C | - | 3 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | - | 3 | µA/V |
| Inverting Input (-IN) Current | $I_{BSN}$ | $V_{CM}$ = 0V | 1 | +25°C | -7.5 | 7.5 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Channel-to-Channel -IN Current Mismatch | $\Delta I_{BSN}$ | $V_{CM}$ = 0V | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | µA |
| -IN Current Common Mode Sensitivity | $CMS_{IBN}$ | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 6 | µA/V |
| | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 8 | µA/V |
| -IN Current Power Supply Sensitivity | $PPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | - | 5 | µA/V |
| | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | - | 8 | µA/V |
| | $NPSS_{IBN}$ | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | - | 5 | µA/V |
| | | | 2 | +125°C | - | 8 | µA/V |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | - | 8 | µA/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$=+3.2V | 1 | +25°C | - | -3 | V |
| | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.8 | V |

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_F = 560\Omega$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, $\overline{DIS}$ = Floated, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Output Voltage Swing | $V_{OP50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = -2.7V$ | 1 | +25°C | 2.5 | - | V |
| | | | $V_{IN} = -2.25V$ | 2 | +125°C | 2.0 | - | V |
| | | | $V_{IN} = -2.25V$ | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V = -1$, $R_L = 50\Omega$ | $V_{IN} = +2.7V$ | 1 | +25°C | - | -2.5 | V |
| | | | $V_{IN} = +2.25V$ | 2 | +125°C | - | -2.0 | V |
| | | | $V_{IN} = +2.25V$ | 3 | -55°C | - | -1.4 | V |
| Output Current | $+I_{OUT}$ | Note 3 | | 1 | +25°C | 50 | - | mA |
| | | | | 2 | +125°C | 40 | - | mA |
| | | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | | 1 | +25°C | - | -50 | mA |
| | | | | 2 | +125°C | - | -40 | mA |
| | | | | 3 | -55°C | - | -28 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | | 1 | +25°C | 5.6 | 6.1 | mA/Op Amp |
| | | | | 2, 3 | +125°C, -55°C | 5.2 | 6.5 | mA/Op Amp |
| | $I_{EE}$ | $R_L = 100\Omega$ | | 1 | +25°C | -6.1 | -5.6 | mA/Op Amp |
| | | | | 2, 3 | +125°C, -55°C | -6.5 | -5.2 | mA/Op Amp |
| Disabled Power Supply Current | $DISI_{CC}$ | $R_L = 100\Omega$, $V_{\overline{DIS}} = 0V$ | | 1 | +25°C | - | 4 | mA/Op Amp |
| | | | | 2, 3 | +125°C, -55°C | - | 4.25 | mA/Op Amp |
| | $DISI_{EE}$ | $R_L = 100\Omega$, $V_{\overline{DIS}} = 0V$ | | 1 | +25°C | -4 | - | mA/Op Amp |
| | | | | 2, 3 | +125°C, -55°C | -4.25 | - | mA/Op Amp |
| Disabled Output Leakage Current | DOLC | $V_{\overline{DIS}} = 0V$, $V_{IN} = \pm2.5V$, $V_{OUT} = \mp2.5V$ | | 1 | +25°C | -10 | 10 | µA |
| | | | | 2, 3 | +125°C, -55°C | -10 | 10 | µA |
| $\overline{\text{Disable}}$ Input Current | DILLC | $V_{\overline{DIS}} = 0V$ | | 1 | +25°C | - | 200 | µA |
| | | | | 2, 3 | +125°C, -55°C | - | 200 | µA |
| | DILHC | $V_{\overline{DIS}} = 5V$ | | 1 | +25°C | - | 15 | µA |
| | | | | 2, 3 | +125°C, -55°C | - | 15 | µA |
| $\overline{\text{Disable}}$ Input Logic Levels | DILLV | | | 1 | +25°C | - | 0.8 | V |
| | | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| | DILHV | | | 1, 2 | +25°C, +125°C | 2.0 | - | V |
| | | | | 3 | -55°C | 2.4 | - | V |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

3

OPERATIONAL AMPLIFIERS

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
69 x 92 x 19 mils ± 1 mils
1750 x 2330 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.4kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

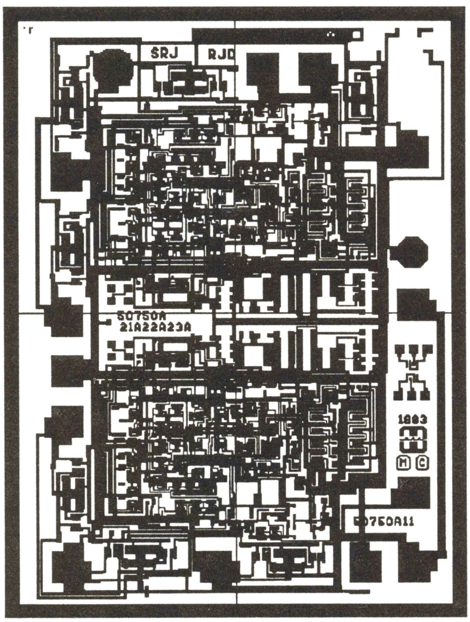
**WORST CASE CURRENT DENSITY:** TBD

**TRANSISTOR COUNT:** 150

**SUBSTRATE POTENTIAL (Powered Up):** Floating (Recommend Connection to V-)

## Metallization Mask Layout

**HFA1245/883**




NOTE:

1. This is an optional GND pad. Users may set a GND reference, via this pad, to ensure the TTL compatibility of the DISABLE inputs when using asymmetrical supplies (e.g. V+ = 10V, V- = 0V). See the "Application Information" section for details.

# HARRIS SEMICONDUCTOR

# HFA1412/883

**PRELIMINARY**

June 1994

## Quad, High Speed, Low Power, Video Closed Loop Buffer

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- User Programmable For Closed-Loop Gains of +1, -1 or +2 Without Use of External Resistors
- Standard Operational Amplifier Pinout
- Low Supply Current........... 5.9mA/Op Amp (Typ)
- Excellent Gain Accuracy.............. 0.99V/V (Typ)
- Wide -3dB Bandwidth ............... 340MHz (Typ)
- Fast Slew Rate .................... 1155V/µs (Typ)
- High Input Impedance .................. 1MΩ (Typ)
- Excellent Gain Flatness (to 50MHz).... ±0.02dB (Typ)
- Fast Overdrive Recovery............... <10ns (Typ)

### Applications

- Flash A/D Driver
- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Medical Imaging Systems

### Description

The HFA1412/883 is a quad closed loop Buffer featuring user programmable gain and high speed performance. Manufactured on Harris' proprietary complementary bipolar UHF-1 process, this device offers wide -3dB bandwidth of 340MHz, very fast slew rate, excellent gain flatness and high output current.

A unique feature of the pinout allows the user to select a voltage gain of +1, -1, or +2, without the use of any external components. Gain selection is accomplished via connections to the inputs, as described in the "Application Information" section. The result is a more flexible product, fewer part types in inventory, and more efficient use of board space.

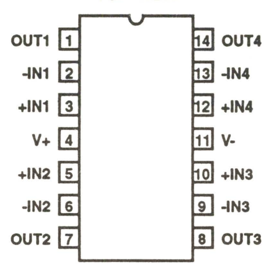
Compatibility with existing op amp pinouts provides flexibility to upgrade low gain amplifiers, while decreasing component count. Unlike most buffers, the standard pinout provides an upgrade path should a higher closed loop gain be needed at a future date.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HFA1412MJ/883 | -55°C to +125°C | 14 Lead CerDIP |

### Pinout

**HFA1412/883**
**(CERDIP)**
TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- .............................. 12V
Voltage at Either Input Terminal ....................... V+ to V-
Output Current (Note 1) ................. Short Circuit Protected
Output Current (50% Duty Cycle, Note 1) ................ 60mA
Junction Temperature ............................. +175°C
ESD Rating ....................................... > 2000V
Storage Temperature Range .............. $-65°C \leq T_A \leq +150°C$
Lead Temperature (Soldering 10s) .................... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 75°C/W | 20°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package ........................... 1.33W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package ........................... 13.3mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating $V_{SUPPLY}$ ($\pm V_S$) .............................. ±5V  $R_L \geq 50\Omega$
Operating Temperature Range ............ $-55°C \leq T_A \leq +125°C$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | 1 | +25°C | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | mV |
| Channel-to-Channel Output Offset Voltage Mismatch | $\Delta V_{OS}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -30 | 30 | mV |
| Common Mode Rejection Ratio | CMRR | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | 42 | - | dB |
| | | | 2 | +125°C | 39 | - | dB |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | 39 | - | dB |
| Power Supply Rejection Ratio | PSRRP | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 6.8V, V- = -5V<br>V+ = 3.2V, V- = -5V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 6.2V, V- = -5V<br>V+ = 3.8V, V- = -5V | 3 | -55°C | 42 | - | dB |
| | PSRRN | $\Delta V_{SUPPLY}$ = ±1.8V<br>V+ = 5V, V- = -6.8V<br>V+ = 5V, V- = -3.2V | 1 | +25°C | 45 | - | dB |
| | | | 2 | +125°C | 42 | - | dB |
| | | $\Delta V_{SUPPLY}$ = ±1.2V<br>V+ = 5V, V- = -6.2V<br>V+ = 5V, V- = -3.8V | 3 | -55°C | 42 | - | dB |
| Non-Inverting Input (+IN) Current | $I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Channel-to-Channel +IN Current Mismatch | $\Delta I_{BSP}$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±5V, $A_V$ = +1, $R_{SOURCE}$ = 0Ω, $R_L$ = 100Ω, $V_{OUT}$ = 0V, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| +IN Current Common Mode Sensitivity | $CMS_{IBP}$ | $\Delta V_{CM}$ = ±1.8V<br>V+ = 3.2V, V- = -6.8V<br>V+ = 6.8V, V- = -3.2V | 1 | +25°C | - | 1.25 | µA/V |
| | | | 2 | +125°C | - | 2.85 | µA/V |
| | | $\Delta V_{CM}$ = ±1.2V<br>V+ = 3.8V, V- = -6.2V<br>V+ = 6.2V, V- = -3.8V | 3 | -55°C | - | 2.85 | µA/V |
| +IN Resistance | $+R_{IN}$ | Note 2 | 1 | +25°C | 800 | - | kΩ |
| | | | 2, 3 | +125°C, -55°C | 350 | - | kΩ |
| Gain | $A_{VP1}$ | $A_V$ = +1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | 0.98 | 1.02 | V/V |
| | | | 2, 3 | +125°C, -55°C | 0.975 | 1.025 | V/V |
| | $A_{VM1}$ | $A_V$ = -1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | -0.98 | -1.02 | V/V |
| | | | 2, 3 | +125°C, -55°C | -0.975 | -1.025 | V/V |
| | $A_{VP2}$ | $A_V$ = +2<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | 1.96 | 2.04 | V/V |
| | | | 2, 3 | +125°C, -55°C | 1.95 | 2.05 | V/V |
| Channel-to-Channel Gain Mismatch | $\Delta A_{VP1}$ | $A_V$ = +1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | -0.02 | 0.02 | V/V |
| | | | 2, 3 | +125°C, -55°C | -0.025 | 0.025 | V/V |
| | $\Delta A_{VM1}$ | $A_V$ = -1<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | -0.02 | 0.02 | V/V |
| | | | 2, 3 | +125°C, -55°C | -0.025 | 0.025 | V/V |
| | $\Delta A_{VP2}$ | $A_V$ = +2<br>$V_{IN}$ = -1V to +1V | 1 | +25°C | -0.04 | 0.04 | V/V |
| | | | 2, 3 | +125°C, -55°C | -0.05 | 0.05 | V/V |
| Output Voltage Swing | $V_{OP100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$ = -3.2V | 1 | +25°C | 3 | - | V |
| | | $V_{IN}$ = -3V | 2, 3 | +125°C, -55°C | 2.8 | - | V |
| | $V_{ON100}$ | $A_V$ = -1, $R_L$ = 100Ω, $V_{IN}$=+3.2V | 1 | +25°C | - | -3 | V |
| | | $V_{IN}$ = +3V | 2, 3 | +125°C, -55°C | - | -2.8 | V |
| Output Voltage Swing | $V_{OP50}$ | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = -2.7V | 1 | +25°C | 2.5 | - | V |
| | | $V_{IN}$ = -2.25V | 2 | +125°C | 2.0 | - | V |
| | | $V_{IN}$ = -2.25V | 3 | -55°C | 1.4 | - | V |
| | $V_{ON50}$ | $A_V$ = -1, $R_L$ = 50Ω, $V_{IN}$ = +2.7V | 1 | +25°C | - | -2.5 | V |
| | | $V_{IN}$ = +2.25V | 2 | +125°C | - | -2.0 | V |
| | | $V_{IN}$ = +2.25V | 3 | -55°C | - | -1.4 | V |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm5V$, $A_V = +1$, $R_{SOURCE} = 0\Omega$, $R_L = 100\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Output Current | $+I_{OUT}$ | Note 3 | 1 | +25°C | 50 | - | mA |
| | | | 2 | +125°C | 40 | - | mA |
| | | | 3 | -55°C | 28 | - | mA |
| | $-I_{OUT}$ | Note 3 | 1 | +25°C | - | -50 | mA |
| | | | 2 | +125°C | - | -40 | mA |
| | | | 3 | -55°C | - | -28 | mA |
| Quiescent Power Supply Current | $I_{CC}$ | $R_L = 100\Omega$ | 1 | +25°C | 5.4 | 6.1 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | 5.0 | 6.5 | mA/Op Amp |
| | $I_{EE}$ | $R_L = 100\Omega$ | 1 | +25°C | -6.1 | -5.4 | mA/Op Amp |
| | | | 2, 3 | +125°C, -55°C | -6.5 | -5.0 | mA/Op Amp |

NOTES:

1. Output is short circuit protected to ground. Brief short circuits to ground will not degrade reliability, however continuous (100% duty cycle) output current must not exceed 30mA for maximum reliability.
2. Guaranteed from +IN Common Mode Rejection Test, by: $+R_{IN} = 1/CMS_{IBP}$ .
3. Guaranteed from $V_{OUT}$ Test with $R_L = 50\Omega$, by: $I_{OUT} = V_{OUT}/50\Omega$.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

# ANALOG 4

## CMOS ANALOG SWITCHES

PAGE

**CMOS ANALOG SWITCH DATA SHEETS**

# DG401/883, DG403/883 DG405/883

June 1994

## Monolithic CMOS Analog Switches



### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- ON-Resistance <35Ω
- Low Power Consumption ($P_D$ <35μW)
- Fast Switching Action
  - $t_{ON}$ <150ns
  - $t_{OFF}$ <100ns
- Low Charge Injection
- DG401/883 Dual SPST; Replaces HI-5041/883
- DG403/883 Dual SPDT; Replaces DG190/883B, IH5043/883B, IH5151/883B, HI-5051/883, HI-5043/883B
- DG405/883 Dual DPST; Replaces DG184/883B, HI-5045/883, IH5145/883B
- TTL, CMOS Compatible
- Single or Split Supply Operation

### Applications

- Audio Switching
- Battery Operated Systems
- Data Acquisition
- Hi-Rel Systems
- Sample and Hold Circuits
- Communication Systems

### Description

The DG401/883, DG403/883 and DG405/883 monolithic CMOS analog switches have TTL and CMOS compatible digital inputs.

These switches feature low analog ON resistance (<35Ω) and fast switch time ($t_{ON}$ <150ns). Low charge injection simplifies sample and hold applications.

The improvements in the DG401/403/405/883 series are made possible by using a high voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. The 44V maximum voltage range permits controlling 30V peak-to-peak signals. Power supplies may be single-ended from +5V to +34V, or split from ±5V to ±17V.

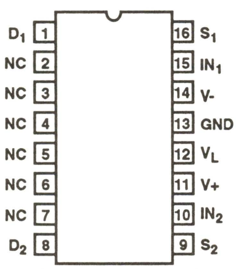
The analog switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±15V analog input range. The three different devices provide the equivalent of two SPST (DG401/883), two SPDT (DG403/883) or two DPST (DG405/883) relay switch contacts with CMOS or TTL level activation. The pinout is similar, permitting a standard layout to be used, choosing the switch function as needed.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| DG401AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG403AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG405AK/883 | -55°C to +125°C | 16 Lead CerDIP |

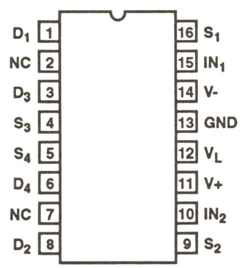
### Pinouts

**DG401/883 (CERDIP)**
TOP VIEW




(NC) NO CONNECTION

**DG403/883, DG405/883 (CERDIP)**
TOP VIEW




(NC) NO CONNECTION

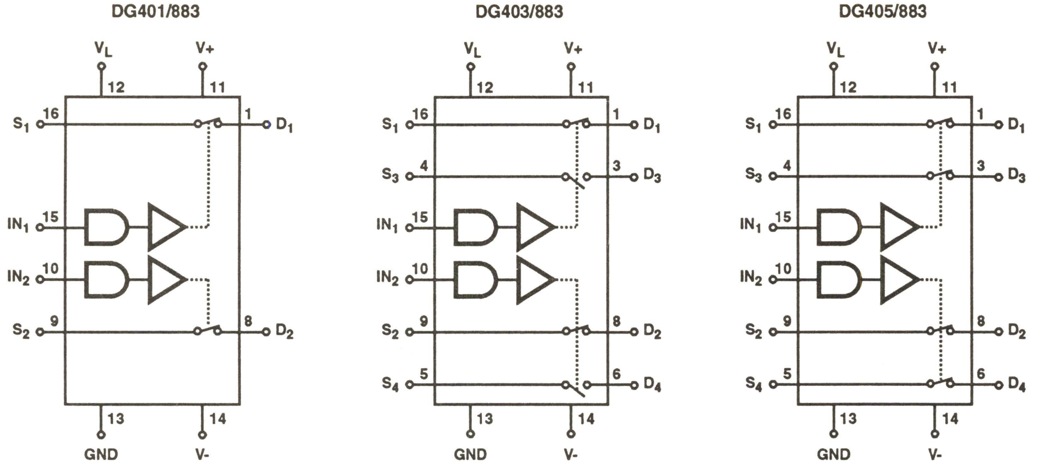
CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.



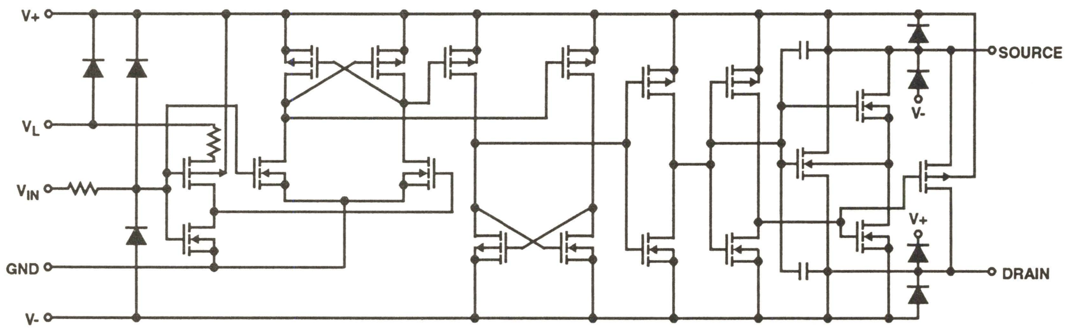


Spec Number 512046
File Number 3703

## Functional Diagrams




## Schematic Diagram




## Truth Table

| LOGIC | DG401/883 | DG403/883 | | DG405/883 |
|---|---|---|---|---|
| | SWITCH | SWITCH 1, 2 | SWITCH 3, 4 | SWITCH |
| 0 | OFF | OFF | ON | OFF |
| 1 | ON | ON | OFF | ON |

NOTE: Logic "0" ≤0.8V. Logic "1" ≥2.4V.

## Absolute Maximum Ratings

V+ to V- . . . . . . . . . . +44.0V
GND to V- . . . . . . . . . . 25V
$V_L$ . . . . . . . . . . (GND - 0.3V) to (VC+) +0.3V
Digital Inputs (Note 1), $V_S$, $V_D$ . . . . . (V-) -2V to (V+) + 2V or 30mA, Whichever Occurs First
Continuous (Any Terminal) Current, (Note 1) . . . . . ±30mA
Peak Current, S or D (Note 1) . . . . . . . . ±100mA
(Pulsed 1ms, 10% Duty Cycle)
Storage Temperature Range (A Suffix) . . . . . -65°C to +125°C
Lead Temperature (Soldering 10s) . . . . . . . +300°C

## Reliability Information

| Thermal Resistance (Max) | $\theta_{JC}$ | $\theta_{JA}$ |
|---|---|---|
| CerDIP Package . . . . . . . . | 18°C/W | 75°C/W |

Operating Temperature (A Suffix) . . . . . . . -55°C to +125°C
Junction Temperature (CerDIP) . . . . . . . . +175°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Voltage Range . . . . . . . . . . ±20V Max
Operating Temperature Range . . . . . . . -55°C to +125°C
Input Low Voltage . . . . . . . . . . 0.8V Max
Input High Voltage . . . . . . . . . . 2.4V Min
Input Rise and Fall Time . . . . . . . . . . 20ns

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at V+ = +15V, V- = -15V, $V_L$ = 5V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Drain-to-Source ON Resistance | $R_{DS(ON)}$ | V+ = +13.5V, V- = -13.5V, $I_S$ = -10mA, $V_D$ = ±10V | 1 | +25°C | - | 35 | Ω |
| | | | 2, 3 | +125°C, -55°C | - | 45 | Ω |
| Delta Drain-to-Source ON Resistance | Delta $R_{DS(ON)}$ | V+ = +16.5V, V- = -16.5V, $I_S$ = -10mA, $V_D$ = +5V, 0V, -5V | 1 | +25°C | - | 3 | Ω |
| | | | 2, 3 | +125°C, -55°C | - | 5 | Ω |
| Source OFF Leakage Current | $I_{S(OFF)}$ | V+ = +16.5V, V- = -16.5V, $V_S$ = -15.5V, $V_D$ = +15.5V | 1 | +25°C | - | ±0.25 | nA |
| | | | 2 | +125°C | - | ±20 | nA |
| | | V+ = +16.5V, V- = -16.5V, $V_S$ = +15.5V, $V_D$ = -15.5V | 1 | +25°C | - | ±0.25 | nA |
| | | | 2 | +125°C | - | ±20 | nA |
| Drain OFF Leakage Current | $I_{D(OFF)}$ | V+ = +16.5V, V- = -16.5V, $V_S$ = -15.5V, $V_D$ = +15.5V | 1 | +25°C | - | ±0.25 | nA |
| | | | 2 | +125°C | - | ±20 | nA |
| | | V+ = +16.5V, V- = -16.5V, $V_S$ = +15.5V, $V_D$ = -15.5V | 1 | +25°C | - | ±0.25 | nA |
| | | | 2 | +125°C | - | ±20 | nA |
| Channel ON Leakage Current | $I_{D(ON)}$ + $I_{S(ON)}$ | V+ = +16.5V, V- = -16.5V, $V_S$ = $V_D$ = ±15.5V | 1 | +25°C | - | ±0.4 | nA |
| | | | 2 | +125°C | - | ±40 | nA |
| Low Level Input Current | $I_{IL}$ | $V_{IN}$ Under Test = 0.8V, All Others = 2.4V | 1, 2 | +25°C, +125°C | - | ±1.0 | µA |
| High Level Input Current | $I_{IH}$ | $V_{IN}$ Under Test = 2.4V, All Others = 0.8V | 1, 2 | +25°C, +125°C | - | ±1.0 | µA |
| Positive Supply Current | I+ | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 0V or 5.0V | 1 | +25°C | - | +1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | - | +5.0 | µA |
| Negative Supply Current | I- | V+ = +16.5V, V- = -16.5V, $V_{IN}$ = 0V or 5.0V | 1 | +25°C | - | -1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | - | -5.0 | |
| Logic Supply Current | $I_L$ | V+ = +16.5V, V- = -16.5V, $V_{IN}$ 0V or 5V | 1 | +25°C | - | +1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | - | +5.0 | |
| Ground Current | $I_{GND}$ | V+ = +16.5V, V- = -16.5V, $V_{IN}$ 0V or 5V | 1 | +25°C | - | -1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | - | -5.0 | |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at V+ = +15V, V- = -15V, $V_L$ = 5V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Turn On Time | $t_{ON}$ | $R_L = 300\Omega$, $C_L = 35pF$ | 9 | +25°C | - | 150 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 275 | ns |
| Turn Off Time | $t_{OFF}$ | $R_L = 300\Omega$, $C_L = 35pF$ | 9 | +25°C | - | 100 | ns |
| | | | 10 | +125°C | - | 250 | ns |
| | | | 11 | -55°C | - | 175 | ns |
| Break-Before-Make Time Delay (DG403 Only) | $t_D$ | $R_L = 300\Omega$, $C_L = 35pF$ | 9 | +25°C | 10 | 150 | ns |

NOTE:

1. Signals on $S_X$, $D_X$, or $IN_X$ exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
2150μm x 1720μm x 485 ± 25μm

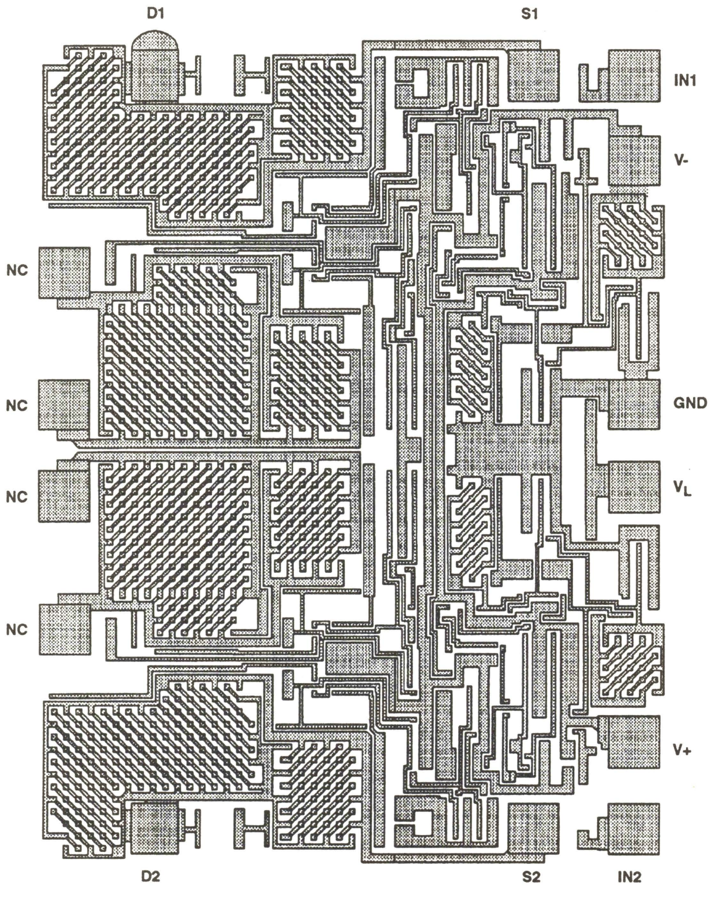
**METALLIZATION:**
Type: Si - Al
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.5 \times 10^5 A/cm^2$

## Metallization Mask Layout

DG401/883



## Die Characteristics

**DIE DIMENSIONS:**
2150μm x 1720μm x 485 ± 25μm

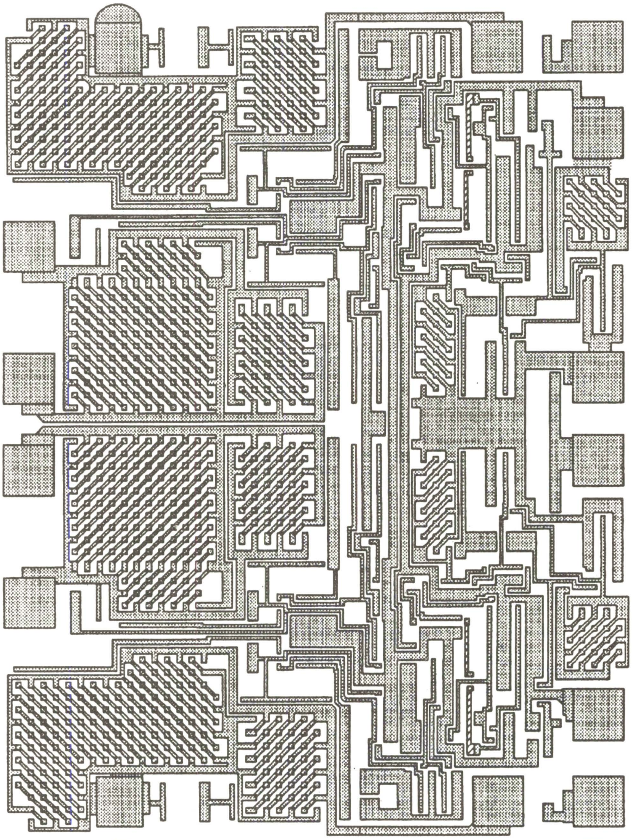
**METALLIZATION:**
Type: Si - Al
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.5 \times 10^5 A/cm^2$

## Metallization Mask Layout

DG403/883, DG405/883



HARRIS SEMICONDUCTOR

# DG411/883, DG412/883 DG413/883

August 1994

## Monolithic Quad SPST CMOS Analog Switches

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **ON-Resistance <35Ω Max**
- **Low Power Consumption ($P_D$ <35μW)**
- **Fast Switching Action**
  - **$t_{ON}$ <175ns**
  - **$t_{OFF}$ <145ns**
- **Low Charge Injection**
- **Upgrade from DG211/DG212**
- **TTL, CMOS Compatible**
- **Single or Split Supply Operation**

### Applications

- **Audio Switching**
- **Battery Operated Systems**
- **Data Acquisition**
- **Hi-Rel Systems**
- **Sample and Hold Circuits**
- **Communication Systems**
- **Automatic Test Equipment**

### Ordering Information

| PART NUMBER | TEMP. RANGE | PACKAGE |
|---|---|---|
| DG411AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG412AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG413AK/883 | -55°C to +125°C | 16 Lead CerDIP |

### Description

The DG411/883 series monolithic CMOS analog switches are drop-in replacements for the popular DG211 and DG212 series devices. They include four independent single pole throw (SPST) analog switches, and TTL and CMOS compatible digital inputs.

These switches feature lower analog ON resistance (<35Ω) and faster switch time ($t_{ON}$ <175ns) compared to the DG211 or DG212. Charge injection has been reduced, simplifying sample and hold applications.

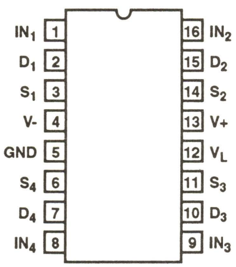
The improvements in the DG411/883 series are made possible by using a high voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. The 44V maximum voltage range permits controlling 40$V_{P-P}$ signals. Power supplies may be single-ended from +5V to +34V, or split from ±5V to ±20V.

The four switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±15V analog input range. The switches in the DG411/883 and DG412/883 are identical, differing only in the polarity of the selection logic. Two of the switches in the DG413/883 (#1 and #4) use the logic of the DG211 and DG411/883 (i.e. a logic "0" turns the switch ON) and the other two switches use DG212 and DG412/883 positive logic. This permits independent control of turn-on and turn-off times for SPDT configurations, permitting "break-before-make" or "make-before-break" operation with a minimum of external logic.



### Pinout

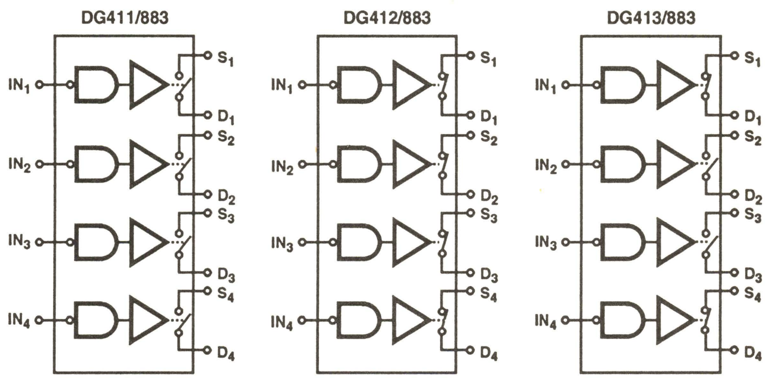
**DG411/883, DG412/883, DG413/883 (CERDIP)**
TOP VIEW




**(NC) NO CONNECTION**

### Functional Diagrams

Four SPST Switches per Package Switches Shown for Logic "1" Input




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 512043
File Number 3681

## Pin Description

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | $IN_1$ | Logic Control for Switch 1 |
| 2 | $D_1$ | Drain (Output) Terminal for Switch 1 |
| 3 | $S_1$ | Source (Input) Terminal for Switch 1 |
| 4 | V- | Negative Power Supply Terminal |
| 5 | GND | Ground Terminal (Logic Common) |
| 6 | $S_4$ | Source (Input) Terminal for Switch 4 |
| 7 | $D_4$ | Drain (Output) Terminal for Switch 4 |
| 8 | $IN_4$ | Logic Control for Switch 4 |
| 9 | $IN_3$ | Logic Control for Switch 3 |
| 10 | $D_3$ | Drain (Output) Terminal for Switch 3 |
| 11 | $S_3$ | Source (Input) Terminal for Switch 3 |
| 12 | $V_L$ | Logic Reference Voltage |
| 13 | V+ | Positive Power Supply Terminal (Substrate) |
| 14 | $S_2$ | Source (Input) Terminal for Switch 2 |
| 15 | $D_2$ | Drain (Output) Terminal for Switch 2 |
| 16 | $IN_2$ | Logic Control for Switch 2 |

**TRUTH TABLE**

| | DG411/ 883 | DG412/ 883 | DG413/883 | |
|---|---|---|---|---|
| LOGIC | SWITCH | SWITCH | SWITCH 1, 4 | SWITCH 2, 3 |
| 0 | ON | OFF | OFF | ON |
| 1 | OFF | ON | ON | OFF |

NOTE: Logic "0" ≤0.8V. Logic "1" ≥2.4V.

## Absolute Maximum Ratings

V+ to V- . . . . . . . . . . 44V
GND to V- . . . . . . . . . . 25V
$V_L$ (Note 2) . . . . . . . . . . (GND -0.3V) to (V+) +0.3V
Digital Inputs, $V_S$, $V_D$ (Note 2) . . . . . (V-) -2V to (V+) + 2V or 30mA, Whichever Occurs First
Continuous Current (Any Terminal) . . . . . . . . . . 30mA
Current, S or D (Pulsed 1ms, 10% Duty Cycle) . . . . . . . . . . 100mA
Storage Temperature Range (A Suffix) . . . . . . . . . . -65°C to +125°C
Lead Temperature (Soldering 10s) . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance (Note 3) | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 85°C/W | 24°C/W |

Junction Temperature . . . . . . . . . . +175°C
Operating Temperature (A Suffix) . . . . . . . . . . -55°C to +125°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Voltage Range . . . . . . . . . . ±20V Max
Operating Temperature Range . . . . . . . . . . -55°C to +125°C
Input Low Voltage . . . . . . . . . . 0.8V Max
Input High Voltage . . . . . . . . . . 2.4V Min
Input Rise and Fall Time . . . . . . . . . . ≤20ns

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V+ = +15V, V- = -15V, $V_L$ = 5V, GND = 0V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Drain-to-Source ON Resistance | $R_{DS(ON)}$ | V+ = +13.5V, V- = -13.5V, $I_S$ = -10mA, $V_D$ = ±8.5V | $V_{IN}$ = 0.8V | 1, 3 | +25°C, -55°C | 0 | 35 | Ω |
| DG411/883 | | | | 2 | +125°C | 0 | 45 | Ω |
| DG412/883 | | | $V_{IN}$ = 2.4V | 1, 3 | +25°C, -55°C | 0 | 35 | Ω |
| | | | | 2 | +125°C | 0 | 45 | Ω |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1, 3 | +25°C, -55°C | 0 | 35 | Ω |
| | | | | 2 | +125°C | 0 | 45 | Ω |
| DG411/883 | | V+ = +10.8V, V- = -0V, $I_S$ = -10mA, $V_D$ = 3.0V and 8.0V | $V_{IN}$ = 0.8V | 1, 3 | +25°C, -55°C | 0 | 80 | Ω |
| | | | | 2 | +125°C | 0 | 100 | Ω |
| DG412/883 | | | $V_{IN}$ = 2.4V | 1, 3 | +25°C, -55°C | 0 | 80 | Ω |
| | | | | 2 | +125°C | 0 | 100 | Ω |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1, 3 | +25°C, -55°C | 0 | 80 | Ω |
| | | | | 2 | +125°C | 0 | 100 | Ω |
| Source OFF Leakage Current | $I_{S(OFF)}$ | V+ = 16.5V, V- = -16.5V, $V_D$ = -15.5V, $V_S$ = 15.5V | $V_{IN}$ = 2.4V | 1 | +25°C | -0.25 | +0.25 | nA |
| DG411/883 | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG412/883 | | | $V_{IN}$ = 0.8V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG411/883 | | V+ = 16.5V, V- = -16.5V, $V_D$ = 15.5V, $V_S$ = -15.5V | $V_{IN}$ = 2.4V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG412/883 | | | $V_{IN}$ = 0.8V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: V+ = +15V, V- = -15V, $V_L$ = 5V, GND = 0V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | MAX | |
| Drain OFF Leakage Current DG411/883 | $I_{D(OFF)}$ | V+ = 16.5V, V- = -16.5V, $V_D$ = -15.5V, $V_S$ = 15.5V | $V_{IN}$ = 2.4V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG412/883 | | | $V_{IN}$ = 0.8V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG411/883 | | V+ = 16.5V, V- = -16.5V, $V_D$ = 15.5V, $V_S$ = -15.5V | $V_{IN}$ = 2.4V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG412/883 | | | $V_{IN}$ = 0.8V | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1 | +25°C | -0.25 | +0.25 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | +20 | nA |
| Channel ON Leakage Current DG411/883 | $I_{D(ON)}$ + $I_{S(ON)}$ | V+ = 16.5V, V- = -16.5V, $V_S$ = $V_D$ = ±15.5V | $V_{IN}$ = 0.8V | 1 | +25°C | -0.4 | +0.4 | nA |
| | | | | 2, 3 | +125°C, -55°C | -40 | +40 | nA |
| DG412/883 | | | $V_{IN}$ = 2.4V | 1 | +25°C | -0.4 | +0.4 | nA |
| | | | | 2, 3 | +125°C, -55°C | -40 | +40 | nA |
| DG413/883 | | | $V_{IN}$ = 0.8V or 2.4V (Note 1) | 1 | +25°C | -0.4 | +0.4 | nA |
| | | | | 2, 3 | +125°C, -55°C | -40 | +40 | nA |
| Input Current with $V_{IN}$ Low | $I_{IL}$ | Input Under Test = 0.8V, All Others = 2.4V | | 1, 2, 3 | +25°C, +125°C, -55°C | -0.5 | +0.5 | μA |
| Input Current with $V_{IN}$ High | $I_{IH}$ | Input Under Test = 2.4V, All Others = 0.8V | | 1, 2, 3 | +25°C, +125°C, -55°C | -0.5 | +0.5 | μA |
| Positive Supply Current | I+ | V+ = 16.5V, V- = -16.5, $V_{IN}$ = 0Vor 5.0V | | 1 | +25°C | - | +1.0 | μA |
| | | | | 2, 3 | +125°C, -55°C | - | +5.0 | μA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0Vor 5.0V $V_L$ = 5.25V | | 1 | +25°C | - | +1.0 | μA |
| | | | | 2, 3 | +125°C, -55°C | - | +5.0 | μA |
| Negative Supply Current | I- | V+ = 16.5V, V- = -16.5, $V_{IN}$ = 0V or 5.0V | | 1 | +25°C | -1.0 | - | μA |
| | | | | 2, 3 | +125°C, -55°C | -5.0 | - | μA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V or 5.0V $V_L$ = 5.25V | | 1 | +25°C | -1.0 | - | μA |
| | | | | 2, 3 | +125°C, -55°C | -5.0 | - | μA |
| Logic Supply Current | $I_L$ | V+ = 16.5V, V- = -16.5, $V_{IN}$ = 0V or 5.0V | | 1 | +25°C | - | +1.0 | μA |
| | | | | 2, 3 | +125°C, -55°C | - | +5.0 | μA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V or 5.0V $V_L$ = 5.25V | | 1 | +25°C | - | +1.0 | μA |
| | | | | 2, 3 | +125°C, -55°C | - | +5.0 | μA |
| Ground Current | $I_{GND}$ | V+ = 16.5V, V- = -16.5, $V_{IN}$ = 0V or 5.0V | | 1 | +25°C | -1.0 | - | μA |
| | | | | 2, 3 | +125°C, -55°C | -5.0 | - | μA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V or 5.0V $V_L$ = 5.25V | | 1 | +25°C | -1.0 | - | μA |
| | | | | 2, 3 | +125°C, -55°C | -5.0 | - | μA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V+ = +15V, V- = -15V, $V_L$ = 5V, GND = 0V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Turn ON Time | $t_{ON}$ | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 300Ω | 9, 11 | +25°C, -55°C | 0 | 175 | ns |
| | | | 10 | +125°C | 0 | 240 | ns |
| | | V+ = 12V, V- = 0V, $C_L$ = 35pF, $V_S$ = +8V, $R_L$ = 300Ω | 9, 11 | +25°C, -55°C | 0 | 250 | ns |
| | | | 10 | +125°C | 0 | 400 | ns |
| Turn OFF Time | $t_{OFF}$ | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 300Ω | 9, 11 | +25°C, -55°C | 0 | 145 | ns |
| | | | 10 | +125°C | 0 | 160 | ns |
| | | V+ = 12V, V- = 0V, $C_L$ = 35pF, $V_S$ = +8V, $R_L$ = 300Ω | 9, 11 | +25°C, -55°C | 0 | 125 | ns |
| | | | 10 | +125°C | 0 | 140 | ns |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)**

Device Tested at: V+ = +15V, V- = -15V, $V_L$ = 5V, GND = 0V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Charge Injection | Q | See Figure 2, $V_G$ = 0V, $R_G$ = 0Ω, $T_A$ = +25°C, $C_L$ = 10nF | 9 | +25°C | -100 | +100 | pC |
| | | | | +25°C | | | pC |
| | | See Figure 2, $V_G$ = 6V, $R_G$ = 0Ω, $T_A$ = +25°C $C_L$ = 10nF, V+ = 12V, V- = 0V | 9 | +25°C | -100 | +100 | pC |
| | | | | +25°C | | | pC |

NOTES:

1. $V_{IN}$ = Input Voltage to Perform Proper Function.
2. Signals on $S_X$, $D_X$ or $IN_X$ exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
3. All leads soldered or welded to PC board.
4. Parameters listed in Table 3 are controlled via design or process and are not directly tested at final production. These parameters are lab characterized upon initial design release or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
2760μm x 1780μm x 485 ± 25μm

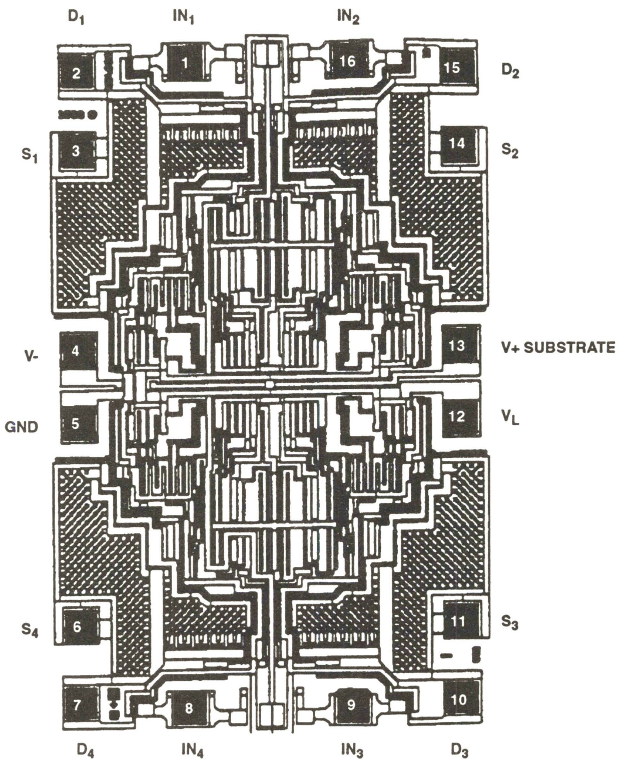
**METALLIZATION:**
Type: SiAl
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.5 \times 10^5 A/cm^2$

## Metallization Mask Layout

**DG411/883, DG412/883, DG413/883**



# HARRIS SEMICONDUCTOR

# DG441/883
# DG442/883

June 1994

## Monolithic Quad SPST CMOS Analog Switches



### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **ON-Resistance 85Ω Max**
- **Low Power Consumption ($P_D$ <1.6mW)**
- **Fast Switching Action**
  - **$t_{ON}$ <250ns**
  - **$t_{OFF}$ <120ns (DG441/883)**
- **Low Charge Injection**
- **Upgrade from DG201A/883/DG202/883**
- **TTL, CMOS Compatible**
- **Single or Split Supply Operation**

### Applications

- **Audio Switching**
- **Battery Operated Systems**
- **Data Acquisition**
- **Hi-Rel Systems**
- **Sample and Hold Circuits**
- **Communication Systems**
- **Automatic Test Equipment**

### Description

The DG441/883 and DG442/883 monolithic CMOS analog switches are drop-in replacements for the popular DG201A/883 and DG202/883 series devices. They include four independent single pole single throw (SPST) analog switches, TTL and CMOS compatible digital inputs, and a voltage reference for logic thresholds.

These switches feature lower analog ON resistance (<85Ω) and faster switch time ($t_{ON}$ <250ns) compared to the DG201A/883 and DG202/883. Charge injection has been reduced, simplifying sample and hold applications.

The improvements in the DG441/883 series are made possible by using a high voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. The 44V maximum voltage range permits controlling 40V peak-to-peak signals. Power supplies may be single-ended from +5V to +34V, or split from ±5V to ±20V.

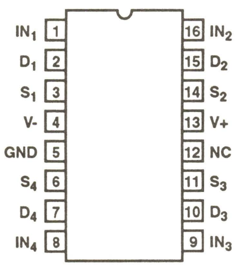
The four switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±5V analog input range. The switches in the DG441/883 and DG442/883 are identical, differing only in the polarity of the selection logic.

### Ordering Information

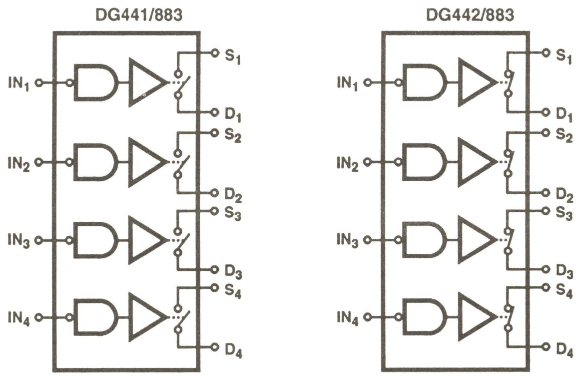
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| DG441AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG442AK/883 | -55°C to +125°C | 16 Lead CerDIP |

### Pinout

**DG441/883, DG442/883**
**(CERDIP)**
TOP VIEW




### Functional Diagrams




**SWITCHES SHOWN FOR LOGIC "1" INPUT**

## Pin Description

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | $IN_1$ | Logic Control for Switch 1 |
| 2 | $D_1$ | Drain (Output) Terminal for Switch 1 |
| 3 | $S_1$ | Source (Input) Terminal for switch 1 |
| 4 | V- | Negative Power Supply Terminal |
| 5 | GND | Ground Terminal (Logic Common) |
| 6 | $S_4$ | Source (Input) Terminal for Switch 4 |
| 7 | $D_4$ | Drain (Output) Terminal for Switch 4 |
| 8 | $IN_4$ | Logic Control for Switch 4 |
| 9 | $IN_3$ | Logic Control for Switch 3 |
| 10 | $D_3$ | Drain (Output) Terminal for Switch 3 |
| 11 | $S_3$ | Source (Input) Terminal for Switch 3 |
| 12 | NC | No Internal Connection |
| 13 | V+ | Positive Power Supply Terminal (Substrate) |
| 14 | $S_2$ | Source (Input) Terminal for Switch 2 |
| 15 | $D_2$ | Drain (Output) Terminal for Switch 2 |
| 16 | $IN_2$ | Logic Control for Switch 2 |

**TRUTH TABLE**

| LOGIC | $V_{IN}$ | DG441 | DG442 |
|---|---|---|---|
| 0 | ≤0.8V | ON | OFF |
| 1 | ≥2.4V | OFF | ON |

## Absolute Maximum Ratings

V+ to V- . . . . . . . . . . 44V
GND to V- . . . . . . . . . . 25V
Digital Inputs, (Note 1) . . . . . . . . . . (V-) -2V to (V+) + 2V or 30mA, Whichever Occurs First
Continuous Current, S or D (Note 1) . . . . . . . . . . ±30mA
Peak Current, S or D (Note 1) . . . . . . . . . . ±100mA
Storage Temperature Range (A Suffix) . . . . . . . . . . -65°C to +150°C
Lead Temperature (Soldering 10s) . . . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance (Max, Note 3) | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 85°C/W | 25°C/W |

Junction Temperature . . . . . . . . . . +175°C
Operating Temperature (A Suffix) . . . . . . . . . . -55°C to +125°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Voltage Range . . . . . . . . . . ±20V Max
Operating Temperature Range . . . . . . . . . . -55°C to +125°C
Input Low Voltage . . . . . . . . . . 0.8V Max
Input High Voltage . . . . . . . . . . 2.4V Min
Input Rise and Fall Time . . . . . . . . . . 20ns

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: -55°C ≤ $T_A$ ≤ +125°C, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|---|
| Drain-to-Source ON Resistance DG441/883 | $R_{DS(ON)}$ | $V_{IN}$ = 0.8V | V+ = +13.5V, V- = -13.5V, $I_S$ = -10mA, $V_D$ = ±8.5V | 1, 3 | +25°C, -55°C | - | 85 | Ω |
| | | | | 2 | +125°C | - | 100 | Ω |
| DG442/883 | | $V_{IN}$ = 2.4V | V+ = +13.5V, V- = -13.5V, $I_S$ = -10mA, $V_D$ = ±8.5V | 1, 3 | +25°C, -55°C | - | 85 | Ω |
| | | | | 2 | +125°C | - | 100 | Ω |
| DG441/883 | | $V_{IN}$ = 0.8V | V+ = +10.8V, V- = 0V, $I_S$ = -10mA, $V_D$ = 3.0V | 1, 3 | +25°C, -55°C | - | 160 | Ω |
| | | | | 2 | +125°C | - | 200 | Ω |
| | | | V+ = +10.8V, V- = 0V, $I_S$ = -10mA, $V_D$ = 8.0V | 1, 3 | +25°C, -55°C | - | 160 | Ω |
| | | | | 2 | +125°C | - | 200 | Ω |
| DG442/883 | | $V_{IN}$ = 2.4V | V+ = +10.8V, V- = 0V, $I_S$ = -10mA, $V_D$ = 3.0V | 1, 3 | +25°C, -55°C | - | 160 | Ω |
| | | | | 2 | +125°C | - | 200 | Ω |
| | | | V+ = +10.8V, V- = 0V, $I_S$ = -10mA, $V_D$ = 8.0V | 1, 3 | +25°C, -55°C | - | 160 | Ω |
| | | | | 2 | +125°C | - | 200 | Ω |
| Source OFF Leakage Current DG441/883 | $I_{S(OFF)}$ | $V_{IN}$ = 2.4V | V+ = +16.5V, V- = -16.5V, $V_S$ = ∓15.5V, $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |
| DG442/883 | | $V_{IN}$ = 0.8V | V+ = +16.5V, V- = -16.5V, $V_S$ = ∓15.5V, $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $-55^oC \leq T_A \leq +125^oC$, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|---|
| Drain OFF Leakage Current DG441/883 | $I_{D(OFF)}$ | $V_{IN}$ = 2.4V | V+ = +16.5V, V- = -16.5V, $V_S$ = ∓15.5V, $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |
| DG442/883 | | $V_{IN}$ = 0.8V | V+ = +16.5V, V- = -16.5V, $V_S$ = ∓15.5V, $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -20 | 20 | nA |
| Channel ON Leakage Current DG441/883 | $I_{D(ON)}$ + $I_{S(ON)}$ | $V_{IN}$ = 0.8V | V+ = +16.5V, V- = -16.5V, $V_S$ = $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -40 | 40 | nA |
| DG442/883 | | $V_{IN}$ = 2.4V | V+ = +16.5V, V- = -16.5V, $V_S$ = $V_D$ = ±15.5V | 1 | +25°C | -0.5 | 0.5 | nA |
| | | | | 2, 3 | +125°C, -55°C | -40 | 40 | nA |
| Input Current with $V_{IN}$ Low | $I_{IL}$ | $V_{IN}$ Under Test = 0.8V, All Others = 2.4V | | 1, 2, 3 | +25°C, +125°C, -55°C | -0.5 | 0.5 | µA |
| Input Current with $V_{IN}$ High | $I_{IH}$ | $V_{IN}$ Under Test = 2.4V, All Others = 0.8V | | 1, 2, 3 | +25°C, +125°C, -55°C | -0.5 | 0.5 | µA |
| Positive Supply Current | I+ | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 0V | | 1, 2, 3 | +25°C, +125°C, -55°C | - | 0.1 | mA |
| | | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 5V | | | | - | 0.1 | mA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V | | | | - | 0.1 | mA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 5V | | | | - | 0.1 | mA |
| Negative Supply Current | I- | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 0V | | 1, 3 | +25°C, -55°C | -1.0 | - | µA |
| | | | | 2 | +125°C | -100 | - | µA |
| | | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 5V | | 1, 3 | +25°C, -55°C | -1.0 | - | µA |
| | | | | 2 | +125°C | -100 | - | µA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V | | 1, 3 | +25°C, -55°C | -1.0 | - | µA |
| | | | | 2 | +125°C | -100 | - | µA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 5V | | 1, 3 | +25°C, -55°C | -1.0 | - | µA |
| | | | | 2 | +125°C | -100 | - | µA |
| Ground Current | $I_{GND}$ | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 0V | | 1, 2, 3 | +25°C, +125°C, -55°C | -100 | - | µA |
| | | V+ = 16.5V, V- = -16.5V, $V_{IN}$ = 5V | | | | -100 | - | µA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 0V | | | | -100 | - | µA |
| | | V+ = 13.2V, V- = 0V, $V_{IN}$ = 5V | | | | -100 | - | µA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $-55^oC \le T_A \le +125^oC$, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Turn ON Time | $t_{ON}$ | | | | | | |
| DG441 | | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 1kΩ | 9 | +25°C | - | 250 | ns |
| DG442 | | | | | - | 315 | ns |
| DG441 | | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 1kΩ | 10, 11 | +125°C, -55°C | - | 300 | ns |
| DG442 | | | | | - | 400 | ns |
| DG441 | | V+ = 12V, V- = 0V, $C_L$ = 35pF, $V_S$ = 8.0V, $R_L$ = 1kΩ | 9 | +25°C | - | 400 | ns |
| DG442 | | | | | - | 450 | ns |
| DG441 | | V+ = 12V, V- = 0V, $C_L$ = 35pF, $V_S$ = 8.0V, $R_L$ = 1kΩ | 10, 11 | +125°C, -55°C | - | 600 | ns |
| DG442 | | | | | - | 675 | ns |
| Turn OFF Time | $t_{OFF}$ | | | | | | |
| DG441 | | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 1kΩ | 9 | +25°C | - | 120 | ns |
| DG442 | | | | | - | 210 | ns |
| DG441 | | $C_L$ = 35pF, $V_S$ = ±10V, $R_L$ = 1kΩ | 10, 11 | +125°C, -55°C | - | 150 | ns |
| DG442 | | | | | - | 250 | ns |
| DG441, DG442 | | V+ = 12V, V- = 0V, $C_L$ = 35pF, $V_S$ = 8.0V, $R_L$ = 1kΩ | 9, 10, 11 | +25°C, +125°C, -55°C | - | 200 | ns |

NOTES:

1. All leads soldered to PC Board.
2. Room: +25°C. Cold: A suffix -55°C, D suffix -40°C. Hot: A suffix +125°C, D suffix +85°C.
3. Dissipation rating assumes device is mounted with all leads soldered to printed circuit board.
4. Typical values are for DESIGN AID ONLY, not guaranteed nor production tested.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
2760μm x 1780μm x 485 ± 25μm

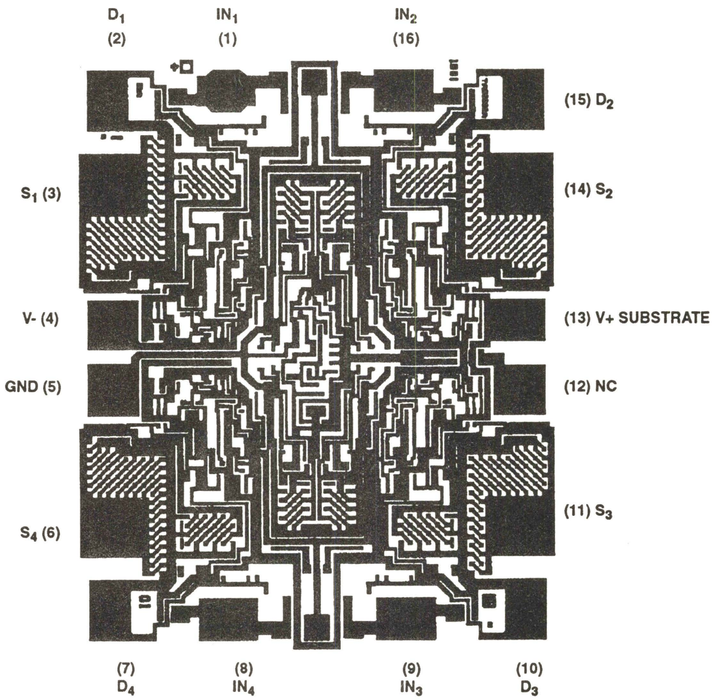
**METALLIZATION:**
Type: SiAl
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$1.5 \times 10^5 A/cm^2$

## Metallization Mask Layout

DG441/883, DG442/883



# ANALOG 5

## CMOS ANALOG MULTIPLEXERS

HARRIS
SEMICONDUCTOR

# DG406/883
# DG407/883

**PRELIMINARY**

June 1994

## Single 16-Channel/Differential 8-Channel CMOS Analog Multiplexers

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- ON-Resistance 100Ω (Max)
- Low Power Consumption ($P_D$ <1.2mW)
- Fast Transition Time (300ns Max)
- Low Charge Injection
- TTL, CMOS Compatible
- Single or Split Supply Operation

### Applications

- Battery Operated Systems
- Data Acquisition
- Medical Instrumentation
- Hi-Rel Systems
- Communication Systems
- Automatic Test Equipment

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| DG406AK/883 | -55°C to +125°C | 28 Lead CerDIP |
| DG407AK/883 | -55°C to +125°C | 28 Lead CerDIP |

### Description

The DG406/883 and DG407/883 monolithic CMOS analog multiplexers are drop-in replacements for the popular DG506A/883 and DG507A/883 series devices. They each include an array of sixteen analog switches, a TTL and CMOS compatible digital decode circuit for channel selection, a voltage reference for logic thresholds, and an ENABLE input for device selection when several multiplexers are present.

These multiplexers feature lower signal ON resistance (<100Ω) and faster transition time ($t_{TRANS}$ <250ns) compared to the DG506A/883 and DG507A/883. Charge injection has been reduced, simplifying sample and hold applications.

The improvements in the DG406 series are made possible by using a high voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. The 44V maximum voltage range permits controlling $30V_{P-P}$ signals when operating with ±15V power supplies.

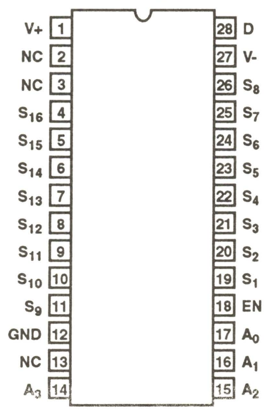
The sixteen switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±5V analog input range.

5

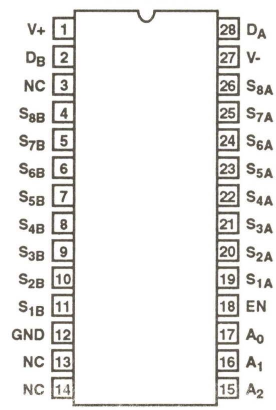
CMOS ANALOG MULTIPLEXERS

### Pinouts

DG406/883
(CERDIP)
TOP VIEW




DG407/883
(CERDIP)
TOP VIEW








Spec Number 512041-883
File Number 3720

DG408/883
DG409/883

# Single 8-Channel/Differential 4-Channel CMOS Analog Multiplexers

June 1994

## Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **ON-Resistance 100Ω Maximum (+25°C)**
- **Low Power Consumption ($P_D$ <11mW)**
- **Fast Switching Action**
  - $t_{TRANS}$ <250ns
  - $t_{ON/OFF(EN)}$ <150ns
- **Low Charge Injection**
- **Upgrade from DG508A/DG509A**
- **TTL, CMOS Compatible**
- **Single or Split Supply Operation**

## Applications

- **Data Acquisition Systems**
- **Audio Switching Systems**
- **Automatic Testers**
- **Hi-Rel Systems**
- **Sample and Hold Circuits**
- **Communication Systems**
- **Analog Selector Switch**

## Description

The DG408/883 Single 8-Channel and DG409/883 Differential 4-Channel monolithic CMOS analog multiplexers are drop-in replacements for the popular DG508A and DG509A series devices. They each include an array of eight analog switches, a TTL/CMOS compatible digital decode circuit for channel selection, a voltage reference for logic thresholds and an ENABLE input for device selection when several multiplexers are present.

The DG408/883 and DG409/883 feature lower signal ON resistance (<100Ω) and faster switch transition time ($t_{TRANS}$ <250ns) compared to the DG508A or DG509A. Charge injection has been reduced, simplifying sample and hold applications. The improvements in the DG408/883 series are made possible by using a high-voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. Power supplies may be single-ended from +5V to +34V, or split from ±5V to ±20V.

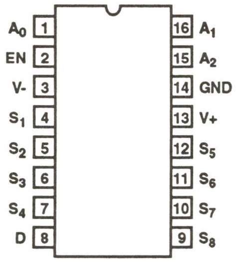
The analog switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±5V analog input range.

## Ordering Information

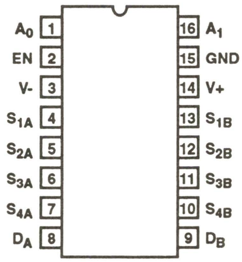
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| DG408AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG409AK/883 | -55°C to +125°C | 16 Lead CerDIP |

## Pinouts

DG408/883
(CERDIP)
TOP VIEW




DG409/883
(CERDIP)
TOP VIEW



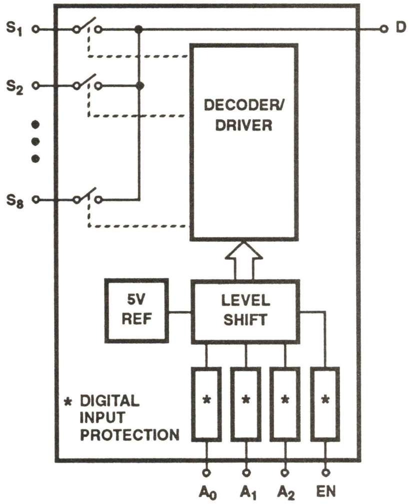




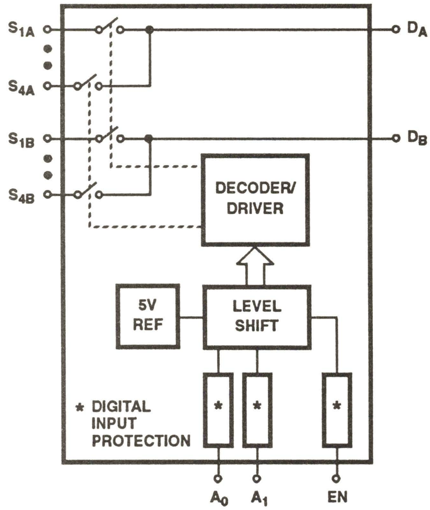

Spec Number 512045
File Number 3688

## Functional Block Diagrams

DG408/883




DG409/883



## Pin Description - (DG408/883)

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | $A_0$ | Logic Decode Input (Bit 0, LSB) |
| 2 | EN | Enable Input |
| 3 | V- | Negative Power Supply Terminal |
| 4 | $S_1$ | Source (Input) for Channel 1 |
| 5 | $S_2$ | Source (Input) for Channel 2 |
| 6 | $S_3$ | Source (Input) for Channel 3 |
| 7 | $S_4$ | Source (Input) for Channel 4 |
| 8 | D | Drain (Output) |
| 9 | $S_8$ | Source (Input) for Channel 8 |
| 10 | $S_7$ | Source (Input) for Channel 7 |
| 11 | $S_6$ | Source (Input) for Channel 6 |
| 12 | $S_5$ | Source (Input) for Channel 5 |
| 13 | V+ | Positive Power Supply Terminal (Substrate) |
| 14 | GND | Ground Terminal (Logic Common) |
| 15 | $A_2$ | Logic Decode Input (Bit 2, MSB) |
| 16 | $A_1$ | Logic Decode Input (Bit 1) |

## Pin Description - (DG409/883)

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | $A_0$ | Logic Decode Input (Bit 0, LSB) |
| 2 | EN | Enable Input |
| 3 | V- | NegAtive Power Supply Terminal |
| 4 | $S_{1A}$ | Source (Input) for Channel 1A |
| 5 | $S_{2A}$ | Source (Input) for Channel 2A |
| 6 | $S_{3A}$ | Source (Input) for Channel 3A |
| 7 | $S_{4A}$ | Source (Input) for Channel 4A |
| 8 | $D_A$ | Drain A (Output A) |
| 9 | $D_B$ | Drain B (Output B) |
| 10 | $S_{4B}$ | Source (Input) for Channel 4B |
| 11 | $S_{3B}$ | Source (Input) for Channel 3B |
| 12 | $S_{2B}$ | Source (Input) for Channel 2B |
| 13 | $S_{1B}$ | Source (Input) for Channel 1B |
| 14 | V+ | Positive Power Supply Terminal |
| 15 | GND | Ground Terminal (Logic Common) |
| 16 | $A_1$ | Logic Decode Input (Bit 1, MSB)) |

TRUTH TABLE DG408/883

| $A_2$ | $A_1$ | $A_0$ | EN | ON SWITCH |
|---|---|---|---|---|
| X | X | X | 0 | NONE |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 0 | 1 | 3 |
| 0 | 1 | 1 | 1 | 4 |
| 1 | 0 | 0 | 1 | 5 |
| 1 | 0 | 1 | 1 | 6 |
| 1 | 1 | 0 | 1 | 7 |
| 1 | 1 | 1 | 1 | 8 |

TRUTH TABLE DG409/883

| $A_1$ | $A_0$ | EN | ON SWITCH |
|---|---|---|---|
| X | X | 0 | NONE |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 2 |
| 1 | 0 | 1 | 3 |
| 1 | 1 | 1 | 4 |

NOTES:

1. $V_{AH}$ Logic "1" ≥2.4V.
2. $V_{AL}$ Logic "0" ≤0.8V.

## Absolute Maximum Ratings

V+ to V- . . . . . . . . +44.0V
GND to V- . . . . . . . . 25V
Digital Inputs (Note 1) . . . . . . . . (V-) -2V to (V+) + 2V or 20mA, Whichever Occurs First
Current (Any Terminal, Except S or D) . . . . . . . . 30mA
Continuous Current, S or D . . . . . . . . 20mA
Peak Current, S or D . . . . . . . . 40mA
(Pulsed 1ms, 10% Duty Cycle)
Storage Temperature Range . . . . . . . . -65°C to +125°C
Lead Temperature (Soldering, 10s) . . . . . . . . +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 70°C/W | 20°C/W |

Operating Temperature . . . . . . . . -55°C to +125°C
Junction Temperature . . . . . . . . +175°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: -55°C ≤ $T_A$ ≤ +125°C, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Drain-Source ON Resistance | $r_{DS(ON)}$ | $V_D$ = ±10V, $V_{AL}$ = 0.8V, $V_{AH}$ = 2.4V, $I_S$ = -10mA, Sequence Each Switch On | 1, 3 | +25°C, -55°C | - | 100 | Ω |
| | | | 2 | +125°C | - | 125 | Ω |
| Difference In Drain-Source ON Resistance Between Channels | $\Delta r_{DS(ON)}$ | $V_D$ = ±10V, $V_{AL}$ = 0.8V, $V_{AH}$ = 2.4V, $I_S$ = -10mA, (Note 2) | 1 | +25°C | - | 15 | Ω |
| Source OFF Leakage Current | $I_{S(OFF)}$ | $V_S$ = ±10V, $V_D$ = ∓10V, $V_{EN}$ = 0V | 1 | +25°C | -0.5 | +0.5 | nA |
| | | | 2 | +125°C | -50 | +50 | nA |
| Drain OFF Leakage Current DG408/883 | $I_{D(OFF)}$ | $V_S$ = ±10V, $V_D$ = ∓10V, $V_{EN}$ = 0V | 1 | +25°C | -1 | +1 | nA |
| | | | 2 | +125°C | -200 | +200 | nA |
| DG409/883 | | | 1 | +25°C | -1 | +1 | nA |
| | | | 2 | +125°C | -100 | +100 | nA |
| Drain ON Leakage Current DG408/883 | $I_{D(ON)}$ | $V_S$ = $V_D$ = ±10V, $V_{AL}$= 0.8V, $V_{AH}$ = 2.4V, $V_{EN}$ = 2.4V, Sequence Each Switch On | 1 | +25°C | -1 | +1 | nA |
| | | | 2 | +125°C | -200 | +200 | nA |
| DG409/883 | | | 1 | +25°C | -1 | +1 | nA |
| | | | 2 | +125°C | -150 | +150 | nA |
| Logic Input Current, Input Voltage High | $I_{AH}$ | $V_{EN}$ = 0.8V, $V_A$ = 2.4V | 1, 2, 3 | +25°C, +125°C, -55°C | -10 | +10 | µA |
| | | $V_{EN}$ = 0.8V, $V_A$ = 15V | | | -10 | +10 | µA |
| Logic Input Current, Input Voltage Low | $I_{AL}$ | $V_{EN}$ = 0V, $V_A$ = 0V | 1, 2, 3 | +25°C, +125°C, -55°C | -10 | +10 | µA |
| | | $V_{EN}$ = 2.4V, $V_A$ = 0V | | | -10 | +10 | µA |
| Positive Supply Current Standby | $I+_{(SB)}$ | $V_{EN}$ = 0V, $V_A$ = 0V | 1, 2, 3 | +25°C, +125°C, -55°C | - | 75 | µA |

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CMOS ANALOG MULTIPLEXERS

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $-55^oC \leq T_A \leq +125^oC$, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Negative Supply Current Standby | $I\text{-}_{(SB)}$ | $V_{EN}$ = 0V, $V_A$ = 0V | 1, 2, 3 | +25°C, +125°C, -55°C | -75 | - | µA |
| Positive Supply Current | I+ | $V_{EN}$ = 2.4V, $V_A$ = 0V | 1, 3 | +25°C, -55°C | - | 0.5 | mA |
| | | | 2 | +125°C | - | 2 | mA |
| Negative Supply Current | I- | $V_{EN}$ = 2.4V, $V_A$ = 0V | 1, 2, 3 | +25°C, +125°C, -55°C | -0.5 | - | mA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $-55^oC \leq T_A \leq +125^oC$, V+ = +15V, V- = -15V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Switching Time of Multiplexer | $t_{TRANS}$ | | 9, 10, 11 | +25°C, +125°C, -55°C | - | 250 | ns |
| Enable Turn ON Time | $t_{ON(EN)}$ | | 9, 11 | +25°C, -55°C | - | 150 | ns |
| | | | 10 | +125°C | - | 225 | ns |
| Enable Turn OFF Time | $t_{OFF(EN)}$ | | 9, 10, 11 | +25°C, +125°C, -55°C | - | 150 | ns |
| Break-Before-Make Interval | $t_{OPEN}$ | | 9 | +25°C | 10 | - | ns |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 3 Intentionally Left Blank.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 3), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTES:

1. Signals on $S_X$, $D_X$, or $IN_X$ exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
2. $\Delta r_{DS(ON)} = r_{DS(ON)}$ MAX - $r_{DS(ON)}$ MIN.
3. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
1800μm x 3320μm x 485 ± 25μm

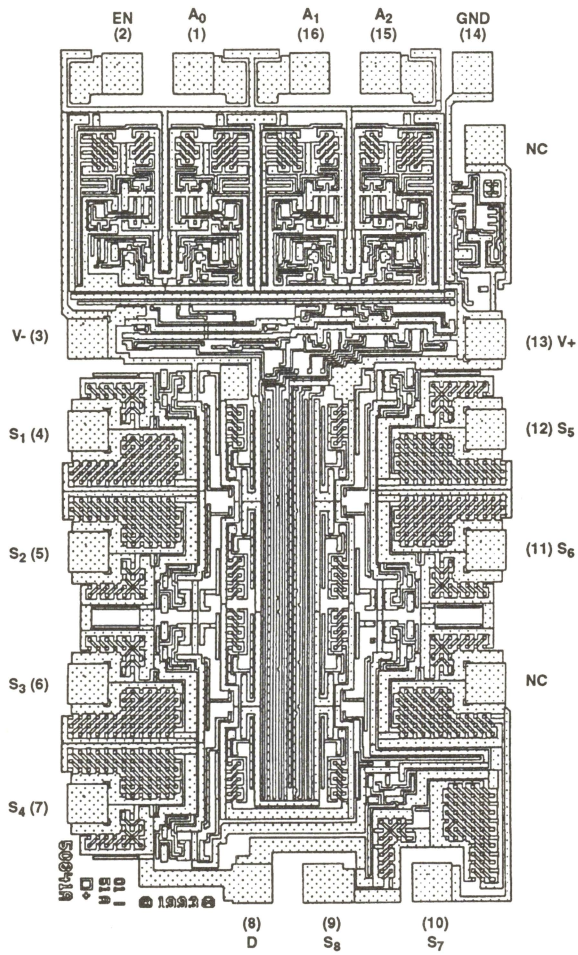
**METALLIZATION:**
Type: SiAl
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$9.1 \times 10^4$ A/cm$^2$

## Metallization Mask Layout

DG408/883



## Die Characteristics

**DIE DIMENSIONS:**
1800μm x 3320μm x 485 ± 25μm

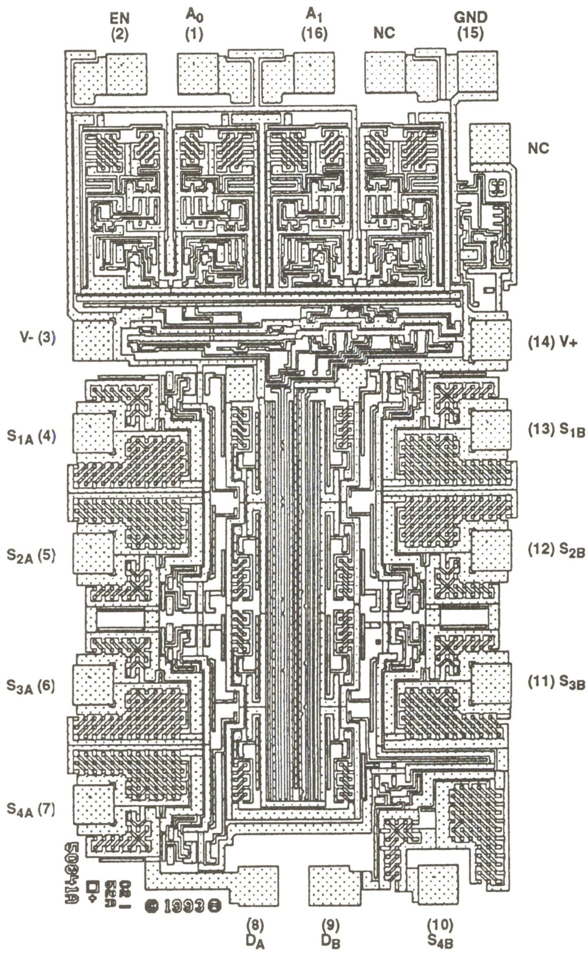
**METALLIZATION:**
Type: SiAl
Thickness: 12kÅ ± 1kÅ

**GLASSIVATION:**
Type: Nitride
Thickness: 8kÅ ± 1kÅ

**WORST CASE CURRENT DENSITY:**
$9.1 \times 10^4$ A/cm$^2$

## Metallization Mask Layout

DG409/883



# HARRIS SEMICONDUCTOR DG458/883, DG459/883

**PRELIMINARY**

June 1994

## Single 8-Channel/Differential 4-Channel Fault Protected Analog Multiplexers

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Fault and Overvoltage Protection
- ON-Resistance <1.5kΩ (+25°C)
- Low Power Consumption ($P_D$ <3mW)
- Fast Switching Action
  - $t_A$ <500ns
  - $t_{ON/OFF(EN)}$ <250ns
- Fail Safe with Power Loss (No Latch-Up)
- Upgrade from IH5108/IH5208
- TTL, CMOS Compatible Logic

### Applications

- Data Acquisition Systems
- Audio Switching Systems
- Automatic Testers
- Hi-Rel Systems
- Sample and Hold Circuits
- Communication Systems
- Analog Selector Switch

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| DG458AK/883 | -55°C to +125°C | 16 Lead CerDIP |
| DG459AK/883 | -55°C to +125°C | 16 Lead CerDIP |

### Description

The DG458/883 Single 8-Channel and DG459/883 Differential 4-Channel monolithic CMOS analog multiplexers are drop-in replacements for the popular IH5108/883 and IH5208/883 series devices. They each include an array of eight analog switches, a series N-Channel/P-Channel/N-Channel fault protection circuit, a TTL/CMOS compatible digital decode circuit for channel selection, a voltage reference for logic thresholds and an ENABLE input for device selection when several multiplexers are present.

The DG458/883 and DG459/883 feature lower signal ON resistance (450Ω typical) and faster switch transition time (200ns typical) compared to the IH5108/883 or IH5208/883. The improvements in the DG458/883 series are made possible by using a high-voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies.

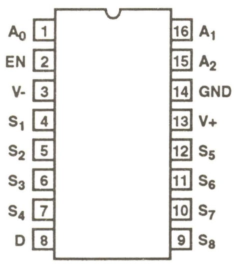
The 44V maximum voltage range permits controlling $20V_{P-P}$ signals, while withstanding continuous overvoltages up to ±35V, providing an open fault circuit.

The analog switches are bilateral, break-before-make, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±5V analog input range.

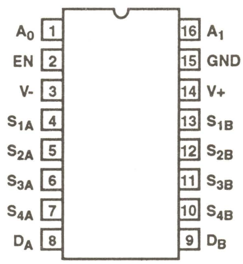


### Pinouts

DG458/883 (CERDIP) TOP VIEW




DG459/883 (CERDIP) TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 512040-883
File Number 3708

# ANALOG 6

## DATA CONVERTERS

PAGE

DATA CONVERTER DATA SHEETS



6

DATA CONVERTERS

HARRIS SEMICONDUCTOR

# HC-55564/883

## Continuously Variable Slope Delta-Modulator (CVSD)

June 1994

### Features

- This Circuit Is Processed In Accordance to MIL-STD-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.Requires Few External Parts
- All Digital
- Requires Few External Parts
- Low Power Drain
- Time Constants Determined by Clock Frequency; No Calibration or Drift Problems: Automatic Offset Adjustment
- Half Duplex Operation Under Digital Control
- Filter Reset Under Digital Control
- Automatic Overload Recovery
- Automatic "Quiet" Pattern Generation
- AGC Control Signal Available

### Applications

- Voice Transmission Over Data Channels (Modems)
- Voice/Data Multiplexing (Pair Gain)
- Voice Encryption/Scrambling
- Voicemail
- Audio Manipulations: Delay Lines, Time Compression, Echo Generation/Suppression, Special Effects, etc.
- Pagers/Satellites
- Data Acquisition Systems
- Voice I/O for Digital Systems and Speech Synthesis Requiring Small Size, Low Weight, and Ease of Reprogrammability

### Description

The HC-55564/883 is a half duplex modulator/demodulator CMOS intergrated circuit used to convert voice signals into serial NRZ digital data and to reconvert that data into voice. The conversion is by delta-modulation, using the Continuously Variable Slope (CVSD) method of modulation/demodulation.

While the signals are compatible with other CVSD circuits, the internal design is unique. The analog loop filters have been replaced by very low power digital filters which require no external timing components. This approach allows inclusion of many desirable features which would be difficult to implement using other approaches.

The fundamental advantages of delta-modulation, along with its simplicity and serial data format, provide an efficient (low data rate/low memory requirements) method for voice digitization. The device may be easily configured with the National TP3040 PCM/CVSD filter.

The HC-55564/883 is usable from 9k bits/sec to above 64kbps. For more applications information, see Application Notes AN576 and AN607.

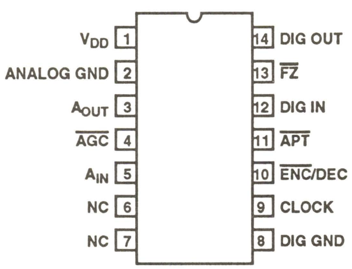
### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HC1-55564/883 | -55°C to +125°C | 14 Lead CerDIP |
| HC4-55564/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

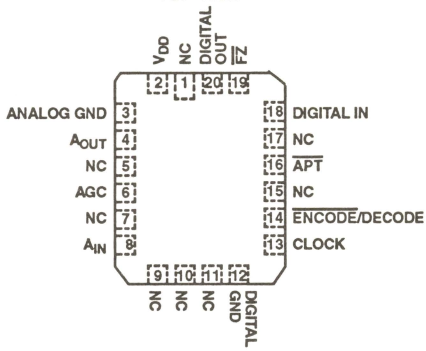


### Pinouts

HC-55564/883
(CERDIP)
TOP VIEW




HC-55564/883
(CLCC)
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 512016-883
File Number 3738

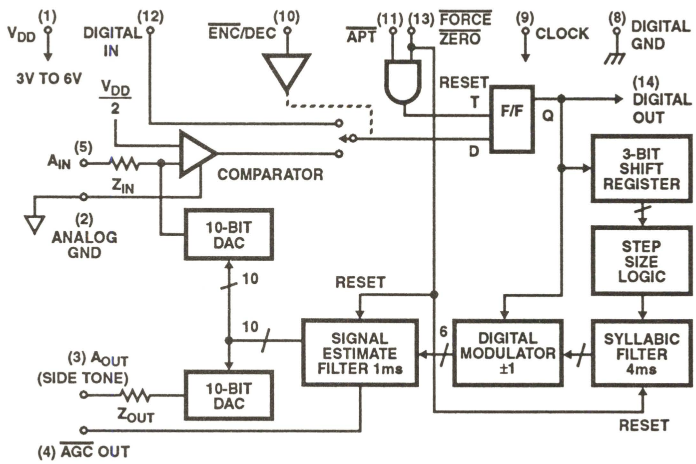
## Pin Description

| PIN NO. 14 LEAD DIP | PIN NO. 20 LEAD LCC | SYMBOL | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | $V_{DD}$ | Positive Supply Voltage. Voltage range is +3.2V to +6.0V. |
| 2 | 3 | Analog GND | Analog Ground connection to D/A ladders and comparator. |
| 3 | 4 | $A_{OUT}$ | Audio Out recovered from 10-bit DAC. May be used as side tone at the transmitter. Presents approximately 75kΩ source with DC offset of $V_{DD}/2$. Within ±2dB of Audio Input. Should be externally AC coupled. |
| 4 | 6 | $\overline{AGC}$ | Automatic Gain Control output. A logic low level will appear at this output when the recovered signal excursion reaches one-half of full scale value. In each half cycle full scale is $V_{DD}/2$. The mark-space ratio is proportional to the average signal level. |
| 5 | 8 | $A_{IN}$ | Audio Input to comparator. Should be externally AC coupled. Presents approximately 200kΩ in series with $V_{DD}/2$. |
| 6, 7 | 1, 5, 7, 9, 10, 11, 15, 17 | NC | No internal connection is made to these pins. |
| 8 | 12 | Digital GND | Logic ground. 0V reference for all logic inputs and outputs. |
| 9 | 13 | Clock | Sampling rate clock. In the decode mode, must be synchronized with the digital input data such that the data is valid at the positive clock transition. In the encode mode, the digital data is clocked out on the negative going clock transition. The clock rate equals the data rate. |
| 10 | 14 | $\overline{\text{Encode}}$/Decode | A single CVSD can provide half-duplex operation. The encode or decode function is selected by the logic level applied to this input. A low level selects the encode mode, a high level the decode mode. |
| 11 | 16 | $\overline{APT}$ | Alternate Plain Text input. Activating this input caused a digital quieting pattern to be transmitted, however; internally the CVSD is still functional and a signal is still available at the $A_{OUT}$ port. Active low. |
| 12 | 18 | Digital In | Input for the received digital NRZ data. |
| 13 | 19 | $\overline{FZ}$ | Force Zero input. Activating this input resets the internal logic and forces the digital output and the recovered audio output into the "quieting" condition. An alternating 1-0 pattern appears at the digital output at 1/2 the clock rate. When this is decoded by a receive CVSD, a $10mV_{P-P}$ inaudible signal appears at audio output. Active low. |
| 14 | 20 | Digital Out | Output for transmitted digital NRZ data. |

NOTE:

1. No active input should be left in a "floating condition".

## Functional Diagram



## Absolute Maximum Ratings

Voltage at Any Pin . . . . . . . . . . . . . . . . . . . GND -0.3V to $V_{DD}$ +0.3V
Maximum $V_{DD}$ Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . +6.0V
Minimum $V_{DD}$ Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . +3.2V
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . . . . . . . . . -65°C to +150°C
Lead Temperature (Soldering 10s) . . . . . . . . . . . . . . . . . . . +300°C
ESD Rating . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . <2000V

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 66°C/W | 16°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |

Package Power Dissipation Limit at +75°C for $T_J$ at ≤ +175°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1.52W
Ceramic LCC Package . . . . . . . . . . . . . . . . . . . . . . . . . . . 1.54W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15.2W/°C
Ceramic LCC Package . . . . . . . . . . . . . . . . . . . . . . . . 15.4W/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Recommended Operating Conditions

Operating Temperature Range . . . . . . . . . . . . . . . . . -55°C to +125°C
Operating Supply Voltage ($V_{DD}$ Range) . . . . . . . . . . . . +3.2V to +6.0V

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY}$ = +5V, fclk = 16kHz, Operating Temperature = -55°C ≤ $T_A$ ≤ +125°C, Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS TYP | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Supply Current | $I_{DD}$ | Encode Mode: $A_{IN}$ = 0V | 1 | +25°C | - | 1.5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 1.5 | mA |
| Logic Input High (Note 2) | $V_{IH}$ | Input Level: '1' = +3.5V, '0' = +1.5V | 1 | +25°C | 3.5 | - | V |
| | | | 2, 3 | +125°C, -55°C | 3.5 | - | V |
| Logic Input Low (Note 2) | $V_{IL}$ | Input Level: '1' = +3.5V, '0' = +1.5V | 1 | +25°C | - | 1.5 | V |
| | | | 2, 3 | +125°C, -55°C | - | 1.5 | V |
| Logic Output High (Note 3) | $V_{OH}$ | $I_{LOAD}$ = -40μA | 1 | +25°C | 4.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 4.0 | - | V |
| Logic Output Low (Note 3) | $V_{OL}$ | $I_{LOAD}$ = +0.8mA | 1 | +25°C | - | 0.4 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.4 | V |
| Quieting Pattern Amplitude (Note 8) | $V_{QP}$ | $\overline{FZ}$ = 0; Clock Inputs Switched Statically | 1 | +25°C | - | 14 | $mV_{P-P}$ |
| | | | 2, 3 | +125°C, -55°C | - | 14 | $mV_{P-P}$ |
| AGC Threshold (Note 9) | $V_{ATH}$ | Encode Mode | 1 | +25°C | 0.45 | 0.65 | F.S. |
| | | | 2, 3 | +125°C, -55°C | 0.45 | 0.65 | F.S. |

### TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Table 2 Intentionally Left Blank.

### TABLE 3. ELECTRICL PERFORMANCE CHARACTERISTICS

Devices Characterized at: $V_{DD}$ = +5.0V, $T_A$ = +25°C, Operating Temperature, fclk = 16kHz Clock Sampling Rate.
$\overline{ENC}$/DDC = $\overline{ENC}$ = Encode Mode, Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | NOTE | TEMPERATURE | LIMITS TYP | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Sampling Rate | CLK | $A_{IN}$ = 0.775 $V_{RMS}$ at 20Hz | 1, 12 | +25°C | 9 | 64 | kBS |
| | | | | +125°C, -55°C | 9 | 64 | kBS |
| CLK Duty Cycle | | $A_{IN}$ = 0.775 $V_{RMS}$ at 100Hz | 12 | +25°C | 30 | 70 | % |
| | | | | +125°C, -55°C | 30 | 70 | % |

**TABLE 3. ELECTRICL PERFORMANCE CHARACTERISTICS (Continued)**

Devices Characterized at: $V_{DD}$ = +5.0V, $T_A$ = +25°C, Operating Temperature, fclk = 16kHz Clock Sampling Rate. $\overline{ENC}$/DDC = $\overline{ENC}$ = Encode Mode, Unless Otherwise Specified. **(Continued)**

| PARAMETER | SYMBOL | CONDITIONS | NOTE | TEMPERATURE | LIMITS TYP | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Audio Input Voltage | $A_{IN}$ | $A_{IN}$ = 100Hz | 4, 12 | +25°C | - | 1.2 | $V_{RMS}$ |
| | | | | +125°C, -55°C | - | 1.2 | $V_{RMS}$ |
| Audio Output Voltage | $A_{OUT}$ | $A_{IN}$ = 100Hz | 5, 12 | +25°C | - | 1.2 | $V_{RMS}$ |
| | | | | +125°C, -55°C | - | 1.2 | $V_{RMS}$ |
| Input Impedance | $Z_{IN}$ | $A_{IN}$ = 100Hz | 6, 12 | +25°C | 150 | 500 | kΩ |
| | | | | +125°C, -55°C | 150 | 500 | kΩ |
| Output Impedance | $Z_{OUT}$ | $A_{IN}$ = 100Hz | 6, 12 | +25°C | 35 | 25 | kΩ |
| | | | | +125°C, -55°C | 35 | 25 | kΩ |
| Transfer Gain | $A_{E-D}$ | $A_{IN}$ = 0.775 $V_{RMS}$ at 100Hz | 11, 12 | +25°C | -2 | +2 | dB |
| | | | | -55°C, +125°C | -2 | +2 | dB |
| Resolution | RES | $A_{IN}$ at 100Hz. Note 8 | 12, 13 | +25°C | 0.3 | - | % of Supply |
| MIN Step Size | MSS | | 7, 12 | +25°C | 0.10 | 0.14 | % of Supply |
| Clamping Threshold | $V_{CTH}$ | | 10, 12 | +25°C | 0.70 | 0.90 | F.S. |

NOTES:

1. There is one NRZ (Non-Return Zero) data bit per clock period. Data is clocked out on the negative clock edge. Data is clocked into the CVSD on the positive going edge (see Figure 2). Clock may be run at less than 9kbps.
2. Logic inputs are CMOS compatible at supply voltage and are diode protected. Digital data input is NRZ at clock rate.
3. Logic outputs are CMOS compatible at supply voltage and will withstand short-circuits to $V_{DD}$ or ground; however, the short circuit duty cycle must not exceed 5% in order to maintain an acceptable current density level. Digital data output is NRZ and changes with negative clock transitions. Each output will drive one LS TTL loads.
4. Recommended voice input range for best voice performance. Should be externally AC coupled.
5. May be used for side-tone in encode mode. Should be externally AC coupled.
6. Presents series impedance with audio signal. Zero signal reference is approximately $V_{DD}/2$. Varies with audio input level by ±2dB.
7. The minimum audio output voltage change that can be produced by the internal DAC.
8. The "quieting" pattern or idle-channel audio output steps at 1/2 the bit rate, changing state on negative clock transitions.
9. A logic "0" will appear at the AGC output pin when the recovered signal reaches one-half of full-scale value (positive or negative), i.e. at $V_{DD}/2$ ±25% of $V_{DD}$.
10. The recovered signal will be clamped, and the computation will be inhibited, when the recovered signal reaches three-quarters of full-scale value, and will unclamp when it falls below this value (positive or negative).
11. No load condition measured from audio in to audio out.
12. The parameters listed in this table are controlled via design or process parameters and are not directly tested. These parameters are characterized upon initial design release and upon design changes which would affect these characteristics.
13. The minimum audio input voltage above which encoding is guaranteed to take place.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
82 x 147 x 20 ± 1 mils

**METALLIZATION:**
Type: AlSi
Thickness: 10kÅ ± 1kÅ

**GLASSIVATION:**
Type: Silane, 3% Phosphorous
Thickness: 13kÅ ± 2.6kÅ

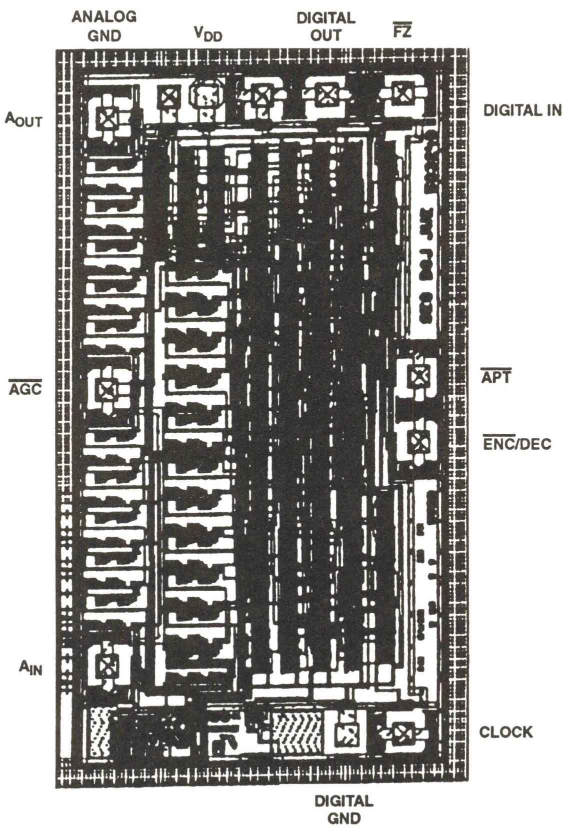
**WORST CASE CURRENT DENSITY:**
$2.0 \times 10^5 A/cm^2$

**TRANSISTOR COUNT:** 1896

**PROCESS:** CMOS; SAJI

## Metallization Mask Layout

HC-55564/883



![HARRIS SEMICONDUCTOR]

# HI-5700/883

June 1994

## 8-Bit, 20 MSPS Flash A/D Converter

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **20 MSPS with No Missing Codes**
- **18MHz Full Power Input Bandwidth**
- **No Missing Codes Over Temperature**
- **Sample and Hold Not Required**
- **Single +5V Supply Voltage**
- **CMOS/TTL**
- **Overflow Bit**

### Applications

- **Video Digitizing**
- **Radar Systems**
- **Medical Imaging**
- **Communication Systems**
- **High Speed Data Acquisition Systems**

### Description

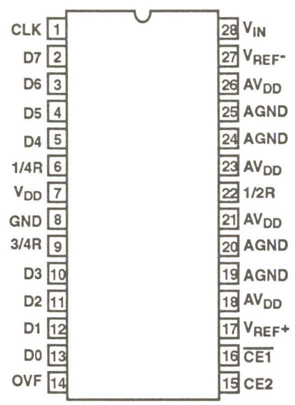
The HI-5700/883 is a monolithic, 8-bit, CMOS Flash Analog-to-Digital Converter. It is designed for high speed applications where wide bandwidth and low power consumption are essential. Its 20 MSPS speed is made possible by a parallel architecture which also eliminates the need for an external sample and hold circuit. The HI-5700/883 delivers ±0.5 LSB differential nonlinearity while consuming only 725mW (typical) at 20 MSPS. Microprocessor compatible data output latches are provided which present valid data to the output bus 1.5 clock cycles after the convert command is received. An overflow bit is provided to allow the series connection of two converters to achieve 9-bit resolution.

### Ordering Information

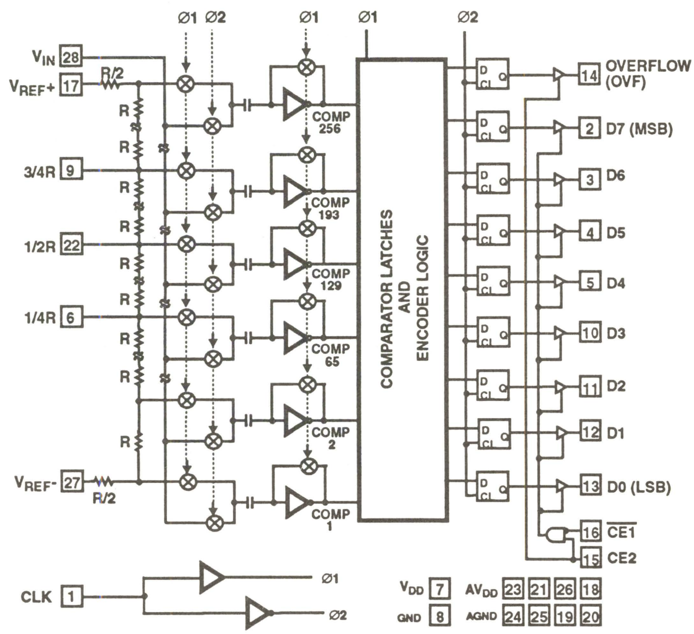
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HI1-5700S/883 | -55°C to +125°C | 28 Lead CerDIP |

### Pinout

HI-5700/883
(28 LEAD CERDIP)
TOP VIEW




### Functional Block Diagram



## Pin Descriptions

| PIN # | NAME | DESCRIPTION |
|---|---|---|
| 1 | CLK | Clock Input |
| 2 | D7 | Bit 7, Output (MSB) |
| 3 | D6 | Bit 6, Output |
| 4 | D5 | Bit 5, Output |
| 5 | D4 | Bit 4, Output |
| 6 | 1/4R | 1/4th Point of Reference Ladder |
| 7 | $V_{DD}$ | Digital Power Supply |
| 8 | GND | Digital Ground |
| 9 | 3/4R | 3/4th Point of Reference Ladder |
| 10 | D3 | Bit 3, Output |
| 11 | D2 | Bit 2, Output |
| 12 | D1 | Bit 1, Output |
| 13 | D0 | Bit 0, Output (LSB) |
| 14 | OVF | Overflow, Output |
| 15 | CE2 | Three-State Output Enable Input, Active High. (See Truth Table) |
| 16 | CE1 | Three-State Output Enable Input, Active Low. (See Truth Table)) |
| 17 | $V_{REF}+$ | Reference Voltage Positive Input |

| PIN # | NAME | DESCRIPTION |
|---|---|---|
| 18 | $AV_{DD}$ | Analog Power Supply, +5V |
| 19 | AGND | Analog Ground |
| 20 | AGND | Analog Ground |
| 21 | $AV_{DD}$ | Analog Power Supply, +5V |
| 22 | 1/2R | 1/2 Point of Reference Ladder |
| 23 | $AV_{DD}$ | Analog Power Supply, +5V |
| 24 | AGND | Analog Ground |
| 25 | AGND | Analog Ground |
| 26 | $AV_{DD}$ | Analog Power Supply, +5V |
| 27 | $V_{REF}-$ | Reference Voltage Negative Input |
| 28 | $V_{IN}$ | Analog Input |

## Chip Enable Truth Table

| CE1 | CE2 | D0 - D7 | OVF |
|---|---|---|---|
| 0 | 1 | Valid | Valid |
| 1 | 1 | Three-State | Valid |
| X | 0 | Three-State | Three-State |

X = Don't Care.

## Absolute Maximum Ratings

Supply Voltage, $V_{DD}$ to GND . . . . . . . . . (GND - 0.5) < $V_{DD}$ < +7.0V
Analog and Reference Input Pins. . ($V_{SS}$ - 0.5) < $V_{INA}$ < ($V_{DD}$ +0.5V)
Digital I/O Pins . . . . . . . . . . . . . . . (GND - 0.5) < $V_{I/O}$ < ($V_{DD}$ +0.5V)
Operating Temperature Range
HI1-5700S/883 . . . . . . . . . . . . . . . . . . . . . . . . . -55°C to +125°C
Junction Temperature . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . . . . . . . -65°C to +150°C
Lead Temperature (Soldering, 10s) . . . . . . . . . . . . . . . . . . . 300°C
ESD Clasification . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Class 1

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| HI1-5700S/883 | 47°C/W | 28°C/W |

Power Dissipation at +75°C (Note 1)
HI1-5700S/883 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2100mW
Power Dissipation Derating Factor Above +75°C
HI1-5700S/883 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 21mW/°C
Reliabiliy Information
Transistor Count . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 14677
Worst Case Density. . . . . . . . . . . . . . . . . . . . . . . . . $3.05 \times 10^4 A/cm^2$

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $AV_{DD} = V_{DD} = +5.0V$; $V_{REF}+ = +4.0V$; $V_{REF}- = GND = AGND = 0V$; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L$ = 30pF; Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|
| ACCURACY | | | | | | | |
| Integral Linearity Error (Best Fit Method) | INL | $F_S$ = 15MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±2.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±2.65 | LSB |
| | | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±2.25 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±4.1 | LSB |
| Differential Linearity Error (Guaranteed No Missing Codes) | DNL | $F_S$ = 15MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±0.9 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±1.0 | LSB |
| | | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±0.9 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±1.0 | LSB |
| Offset Error (Adjustable to Zero) | VOS | $F_S$ = 15MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±8.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±9.5 | LSB |
| | | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±8.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±9.5 | LSB |
| Full Scale Error (Adjustable to Zero) | FSE | $F_S$ = 15MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±4.5 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±8.0 | LSB |
| | | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±4.5 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±8.0 | LSB |
| ANALOG INPUT | | | | | | | |
| Analog Input Resistance | $R_{IN}$ | $V_{IN}$ = 4V | 1 | +25°C | 4 | - | MΩ |
| | | | 2, 3 | +125°C, -55°C | 4 | - | MΩ |
| Analog Input Bias Current | $I_B$ | $V_{IN}$ = 0V, 4V | 1 | +25°C | | ±1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | | ±1.0 | µA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $AV_{DD} = V_{DD} = +5.0V$; $V_{REF}+ = +4.0V$; $V_{REF}- = GND = AGND = 0V$; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L = 30pF$; Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|
| REFERENCE INPUT | | | | | | | |
| Total Reference Resistance | $R_L$ | | 1 | +25°C | 250 | - | Ω |
| | | | 2, 3 | +125°C, -55°C | 235 | - | Ω |
| DIGITAL INPUTS | | | | | | | |
| Input High Voltage | $V_{IH}$ | | 1 | +25°C | 2.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.0 | - | V |
| Input Low Voltage | $V_{IL}$ | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| Logic Input Current | $I_{IN}$ | $V_{IN}$ = 0V, +5V | 1 | +25°C | - | ±1 | μA |
| | | | 2, 3 | +125°C, -55°C | - | ±1 | μA |
| DIGITAL OUTPUTS | | | | | | | |
| Output Leakage | $I_{OZ}$ | CE2 = 0V, $V_O$ = 0V, 5V | 1 | +25°C | - | ±1.0 | μA |
| | | | 2, 3 | +125°C, -55°C | - | ±1.0 | μA |
| Output Logic Source Current | $I_{OH}$ | $V_O$ = 4.5V | 1 | +25°C | -3.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -3.2 | - | mA |
| Output Logic Sink Current | $I_{OL}$ | $V_O$ = 0.4V | 1 | +25°C | 3.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 3.2 | - | mA |
| POWER SUPPLY REJECTION | | | | | | | |
| Offset Error PSRR | ΔVOS | $V_{DD}$ = 5V ±10% | 1 | +25°C | - | ±2.75 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±5.5 | LSB |
| Gain Error PSRR | ΔFSE | $V_{DD}$ = 5V ±10% | 1 | +25°C | - | ±2.75 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±5.5 | LSB |
| POWER SUPPLY CURRENT | | | | | | | |
| Supply Current | $I_{DD}$ | $F_S$ = 20MHz | 1 | +25°C | - | 180 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 190 | mA |

NOTE:

1. Dissipation rating assumes device is mounted with all leads soldered to printed circuit board.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $AV_{DD} = V_{DD} = +5.0V$; $V_{REF}+ = +4.0V$; $V_{REF}- = GND = AGND = 0V$; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L = 30pF$; Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Maximum Conversion Rate | | No Missing Codes | 9 | +25°C | 20 | - | MSPS |
| | | | 10, 11 | +125°C, -55°C | 20 | - | MSPS |
| Data Output Enable Time | $t_{EN}$ | | 9 | +25°C | - | 25 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 30 | ns |
| Data Output Disable Time | $t_{DIS}$ | | 9 | +25°C | - | 20 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 25 | ns |
| Data Output Delay | $t_{OD}$ | | 9 | +25°C | - | 25 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 30 | ns |
| Data Output Hold | $t_H$ | | 9 | +25°C | 10 | - | ns |
| | | | 10, 11 | +125°C, -55°C | 5 | - | ns |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)

Device Characterized at: $AV_{DD} = V_{DD} = +5.0V$; $V_{REF}+ = +4.0V$; $V_{REF}- = GND = AGND = 0V$; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L = 30pF$; Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|
| Minimum Conversion Rate | | No Missing Codes | +25°C, +125°C, -55°C | - | 0.125 | MSPS |

NOTE:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C & D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

## *Die Characteristics*

**DIE DIMENSIONS:**
154.3 x 173.2 x 19 ± 1mils

**METALLIZATION:**
Type: Si - Al
Thickness: 11kÅ ± 1kÅ

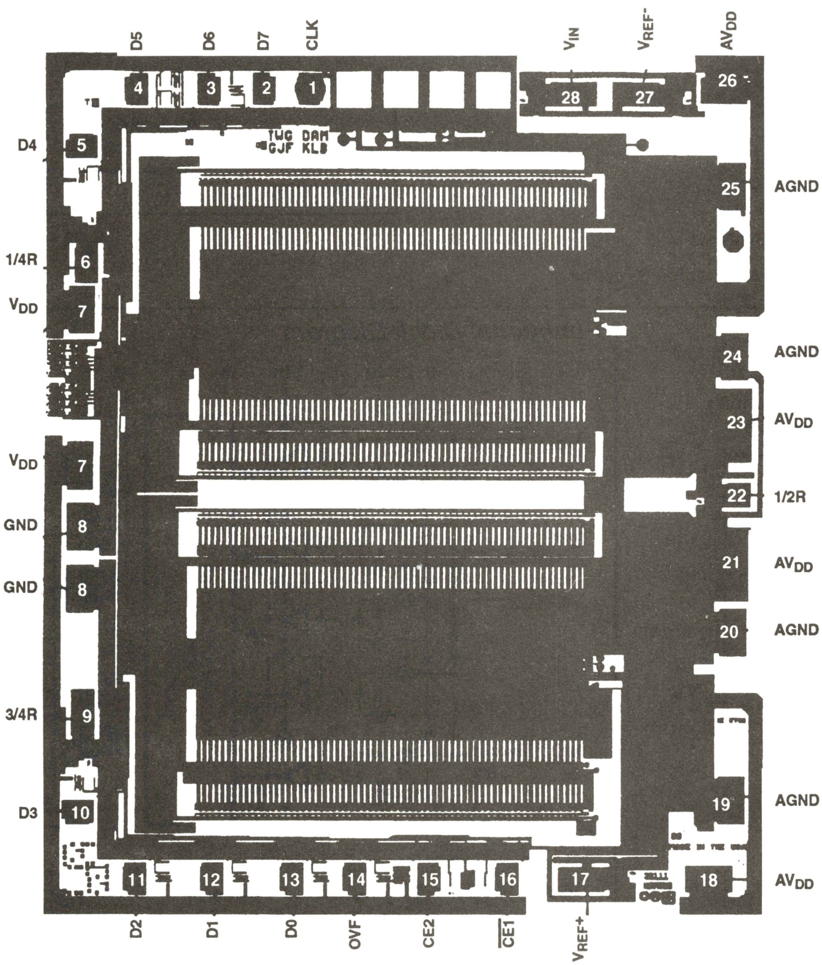
**GLASSIVATION:**
Type: $SiO_2$
Thickness: 8kÅ ± 1kÅ

**DIE ATTACH:**
Material: Gold Silicon Eutectic Alloy
Temperature: Ceramic DIP - 460°C (Max)

**WORST CASE CURRENT DENSITY:**
$3.05 \times 10^4$ A/cm$^2$

## *Metallization Mask Layout*

HI-5700/883




6
DATA CONVERTERS

# HI-5701/883

June 1994

## 6-Bit, 30 MSPS Flash A/D Converter

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **30 MSPS with No Missing Codes**
- **20MHz Full Power Input Bandwidth**
- **No Missing Codes Over Temperature**
- **Sample and Hold Not Required**
- **Single +5V Supply Voltage**
- **CMOS/TTL**
- **Overflow Bit**

### Applications

- **Video Digitizing**
- **Radar Systems**
- **Medical Imaging**
- **Communication Systems**
- **High Speed Data Acquisition Systems**

### Description

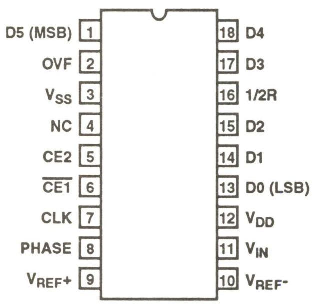
The HI-5701/883 is a monolithic, 6-bit, CMOS Flash Analog-to-Digital Converter. It is designed for high speed applications where wide bandwidth and low power consumption are essential. Its 30 MSPS speed is made possible by a parallel architecture which also eliminates the need for an external sample and hold circuit. The HI-5701/883 delivers ±0.7 LSB differential nonlinearity while consuming only 250mW (typical) at 30 MSPS. Microprocessor compatible data output latches are provided which present valid data to the output bus 1.5 clock cycles after the convert command is received. An overflow bit is provided to allow the series connection of two converters to achieve 7-bit resolution.

### Ordering Information

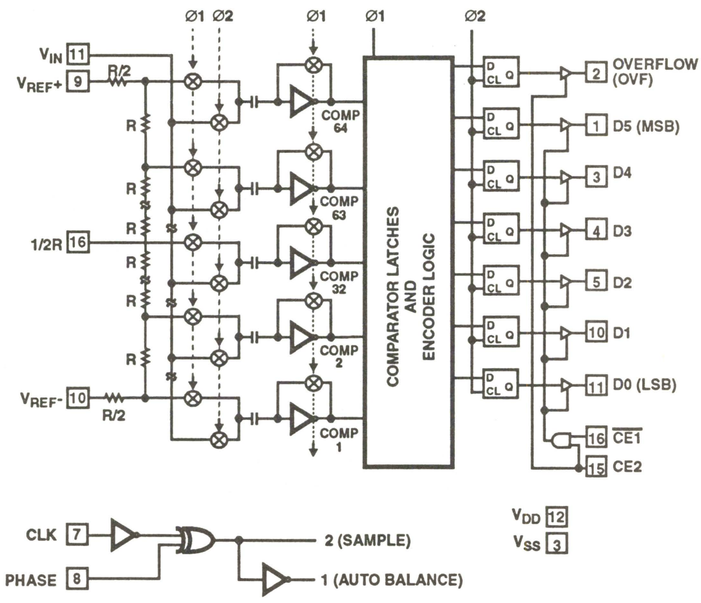
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HI1-5701T/883 | -55°C to +125°C | 18 Lead CerDIP |

### Pinout

**HI-5701/883**
**(18 LEAD CERDIP)**
TOP VIEW




### Functional Block Diagram




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.





Spec Number 512031
File Number 3378

## Pin Description

| PIN # | NAME | DESCRIPTION |
|---|---|---|
| 1 | D5 | Bit 6, Output (MSB) |
| 2 | OVF | Overflow, Output |
| 3 | $V_{SS}$ | Digital Ground |
| 4 | NC | No Connection |
| 5 | CE2 | Three-State Output Enable Input, Active high (See Truth Table) |
| 6 | $\overline{CE1}$ | Three-State Output Enable Input, Active Low (See Truth Table) |
| 7 | CLK | Clock Input |
| 8 | PHASE | Sample Clock Phase Control Input. When Phase is Low, Sample Unknown ($\phi$1) occurs when the Clock is Low and Auto Balance ($\phi$2) occurs when the Clock is High (See Phase Control Table) |
| 9 | $V_{REF}+$ | Reference Voltage Positive Input |
| 10 | $V_{REF}-$ | Reference Voltage Negative Input |
| 11 | $V_{IN}$ | Analog Signal Input |
| 12 | $V_{DD}$ | Power Supply, +5V |
| 13 | D0 | Bit 1, Output (LSB) |
| 14 | D1 | Bit 2, Output |
| 15 | D2 | Bit 3, Output |
| 16 | 1/2R | Reference Ladder Midpoint |
| 17 | D3 | Bit 4, Output |
| 18 | D4 | Bit 5, Output |

## Chip Enable Truth Table

| $\overline{CE1}$ | CE2 | D0 - D5 | OVF |
|---|---|---|---|
| 0 | 1 | Valid | Valid |
| 1 | 1 | Three-State | Valid |
| X | 0 | Three-State | Three-State |

X = Don't Care.

## Phase Control

| CLOCK | PHASE | INTERNAL GENERATION |
|---|---|---|
| 0 | 0 | Sample Unknown ($\phi$2) |
| 0 | 1 | Auto Balance ($\phi$1) |
| 1 | 0 | Auto Balance ($\phi$1) |
| 1 | 1 | Sample Unknown ($\phi$2) |

## Absolute Maximum Ratings

Supply Voltage, $V_{DD}$ to $V_{SS}$ . . . . . . . . . . . ($V_{SS}$ - 0.5) < $V_{DD}$ < +7.0V
Analog and Reference Input Pins. . ($V_{SS}$ - 0.5) < $V_{INA}$ < ($V_{DD}$ +0.5V)
Digital I/O Pins . . . . . . . . . . . . . . . . ($V_{SS}$ - 0.5) < $V_{I/O}$ < ($V_{DD}$ +0.5V)
Operating Temperature Range
HI1-5701T/883 . . . . . . . . . . . . . . . . . . . . . . . . . -55°C to +125°C
Junction Temperature. . . . . . . . . . . . . . . . . . . . . . . . . . . . . +175°C
Storage Temperature Range . . . . . . . . . . . . . . . . -65°C to +150°C
Lead Temperature (Soldering, 10s) . . . . . . . . . . . . . . . . . . . . 300°C
ESD Clasification . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Class 1

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| HI1-5701T/883. . . . . . . . . . . . . . . . . . . . . | 70°C/W | 28°C/W |

Power Dissipation at +75°C (Note 1)
HI1-5701T/883. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1.4mW
Power Dissipation Derating Factor Above +75°C
HI1-5701T/883. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 14mW/°C
Reliability Information
Transistor Count . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4815
Worst Case Density . . . . . . . . . . . . . . . . . . . . . . . 3.05 x $10^4$A/cm$^2$

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{DD}$ = +5.0V; $V_{REF}$+ = +4.0V; $V_{REF}$- = $V_{SS}$ = GND; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L$ = 30pF; Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|
| ACCURACY | | | | | | | |
| Integral Linearity Error (Best Fit Method) | INL | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±1.25 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±2.0 | LSB |
| | | $F_S$ = 30MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±1.5 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±2.5 | LSB |
| Differential Linearity Error (Guaranteed No Missing Codes) | DNL | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±0.6 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±0.75 | LSB |
| | | $F_S$ = 30MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±0.75 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±1.0 | LSB |
| Offset Error (Adjustable to Zero) | VOS | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±2.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±2.5 | LSB |
| Full Scale Error (Adjustable to Zero) | FSE | $F_S$ = 20MHz, $f_{IN}$ = DC | 1 | +25°C | - | ±2.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±2.5 | LSB |
| ANALOG INPUT | | | | | | | |
| Analog Input Resistance | $R_{IN}$ | $V_{IN}$ = 4V | 1 | +25°C | 4 | - | MΩ |
| | | | 2, 3 | +125°C, -55°C | 4 | - | MΩ |
| Analog Input Bias Current | $I_B$ | $V_{IN}$ = 0V, 4V | 1 | +25°C | | ±1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | | ±1.0 | µA |
| REFERENCE INPUT | | | | | | | |
| Total Reference Resistance | $R_L$ | | 1 | +25°C | 250 | - | Ω |
| | | | 2, 3 | +125°C, -55°C | 235 | - | Ω |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{DD}$ = +5.0V; $V_{REF}+$ = +4.0V; $V_{REF}-$ = $V_{SS}$ = GND; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L$ = 30pF; Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| DIGITAL INPUTS | | | | | | | |
| Input High Voltage | $V_{IH}$ | | 1 | +25°C | 2.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.0 | - | V |
| Input Low Voltage | $V_{IL}$ | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| Logic Input Current | $I_{IN}$ | $V_{IN}$ = 0V, +5V | 1 | +25°C | - | ±1 | µA |
| | | | 2, 3 | +125°C, -55°C | - | ±1 | µA |
| DIGITAL OUTPUTS | | | | | | | |
| Output Leakage | $I_{OZ}$ | CE2 = 0V, $V_O$ = 0V, 5V | 1 | +25°C | - | ±1.0 | µA |
| | | | 2, 3 | +125°C, -55°C | - | ±1.0 | µA |
| Output Logic Source Current | $I_{OH}$ | $V_O$ = 4.5V | 1 | +25°C | -3.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -3.2 | - | mA |
| Output Logic Sink Current | $I_{OL}$ | $V_O$ = 0.4V | 1 | +25°C | 3.2 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 3.2 | - | mA |
| POWER SUPPLY REJECTION | | | | | | | |
| Offset Error PSRR | ΔVOS | $V_{DD}$ = 5V ±10% | 1 | +25°C | - | ±1.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±1.5 | LSB |
| Gain Error PSRR | ΔFSE | $V_{DD}$ = 5V ±10% | 1 | +25°C | - | ±1.0 | LSB |
| | | | 2, 3 | +125°C, -55°C | - | ±1.5 | LSB |
| POWER SUPPLY CURRENT | | | | | | | |
| Supply Current | $I_{DD}$ | $F_S$ = 30MHz | 1 | +25°C | - | 60 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 75 | mA |

NOTE:

1. Dissipation rating assumes device is mounted with all leads soldered to printed circuit board.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{DD}$ = +5.0V; $V_{REF}+$ = +4.0V; $V_{REF}-$ = $V_{SS}$ = GND; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L$ = 30pF; Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Maximum Conversion Rate | | No Missing Codes | 9 | +25°C | 30 | - | MSPS |
| | | | 10, 11 | +125°C, -55°C | 30 | - | MSPS |
| Data Output Enable Time | $t_{EN}$ | | 9 | +25°C | - | 20 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 20 | ns |
| Data Output Disable Time | $t_{DIS}$ | | 9 | +25°C | - | 20 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 20 | ns |
| Data Output Delay | $t_{OD}$ | | 9 | +25°C | - | 20 | ns |
| | | | 10, 11 | +125°C, -55°C | - | 20 | ns |
| Data Output Hold | $t_H$ | | 9 | +25°C | 10 | - | ns |
| | | | 10, 11 | +125°C, -55°C | 5 | - | ns |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)

Device Characterized at: $V_{DD}$ = +5.0V; $V_{REF}+$ = +4.0V; $V_{REF}-$ = $V_{SS}$ = GND; $F_S$ = Specified Clock Frequency at 50% Duty Cycle; $C_L$ = 30pF; Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|
| Minimum Conversion Rate | | No Missing Codes | +25°C, +125°C, -55°C | - | 0.125 | MSPS |

NOTE:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | 1 |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3, 9, 10, 11 |
| Group A Test Requirements | 1, 2, 3, 9, 10, 11 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

## Die Characteristics

**DIE DIMENSIONS:**
2220μm x 3320μm x 19 ± 1mils

**METALLIZATION:**
Type: Si - Al
Thickness: 11kÅ ± 1kÅ

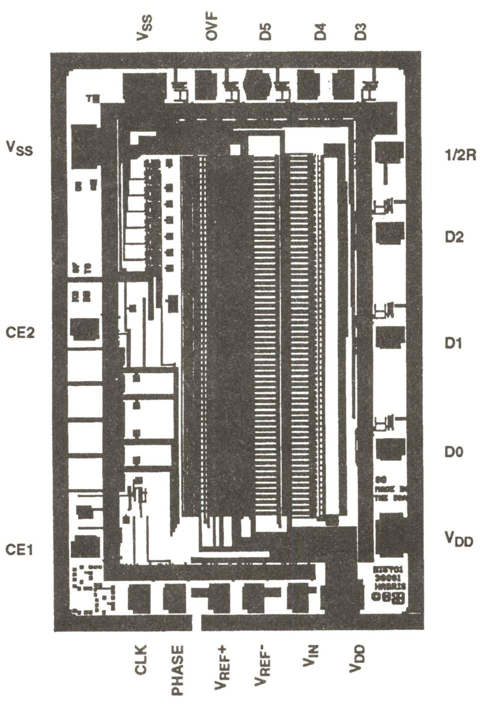
**GLASSIVATION:**
Type: $SiO_2$
Thickness: 8kÅ ± 1kÅ

**DIE ATTACH:**
Material: Gold Silicon Eutectic Alloy
Temperature: Ceramic DIP - 460°C (Max)

**WORST CASE CURRENT DENSITY:**
$3.05 \times 10^4$ A/cm$^2$

## Metallization Mask Layout

HI-5701/883




6 DATA CONVERTERS

# ANALOG 7

## SAMPLE AND HOLD AMPLIFIERS

PAGE

**SAMPLE AND HOLD AMPLIFIER DATA SHEETS**



7

SAMPLE AND HOLD AMPLIFIERS

HARRIS SEMICONDUCTOR

# HA-5320/883

July 1994

## High Speed Precision Sample and Hold Amplifier

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Gain, DC . . . . . . . . . . . . . . . . . . . . . . . . $2 \times 10^6$ V/V (Typ)**
- **Acquisition Time . . . . . . . . . . . . . . . . 1.0µs (0.01%) (Typ)**
- **Droop Rate . . . . . . . . . . . . . . . . . 0.08µV/µs (+25°C) (Typ)**
  **17µV/µs (Full Temperature) (Typ)**
- **Aperture Time . . . . . . . . . . . . . . . . . . . . . . . 25ns (Typ)**
- **Hold Step Error . . . . . . . . . . . . . . . . . . . . . . 1.0mV (Typ)**
- **Internal Hold Capacitor**
- **Fully Differential Input**
- **TTL Compatible**

### Applications

- **High Bandwidth Precision Data Acquisition Systems**
- **Inertial Navigation and Guidance Systems**
- **Ultrasonics**
- **SONAR / RADAR**
- **Digital to Analog Converter Deglitcher**

### Description

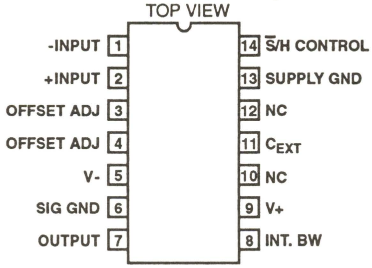
The HA-5320/883 was designed for use in precision, high speed data acquisition systems.

The circuit consists of an input transconductance amplifier capable of providing large amounts of charging current, a low leakage analog switch, and an output integrating amplifier. The analog switch sees virtual ground as its load; therefore, charge injection on the hold capacitor is constant over the entire input/output voltage range. The pedestal voltage resulting from this charge injection can be adjusted to zero by use of the offset adjust inputs. The device includes a hold capacitor. However, if improved droop rate is required at the expense of acquisition time, additional hold capacitance may be added externally.

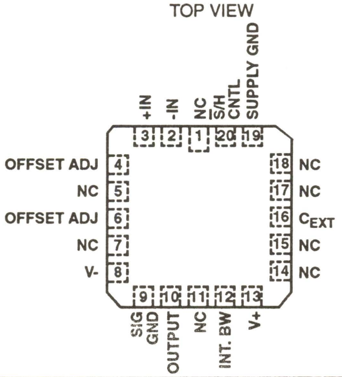
This monolithic device is manufactured using the Harris Dielectric Isolation Process, minimizing stray capacitance and eliminating SCR's. This allows higher speed and latch-free operation. For further information, please see Application Note AN538.

### Pinouts

HA-5320/883 (CERDIP)
TOP VIEW



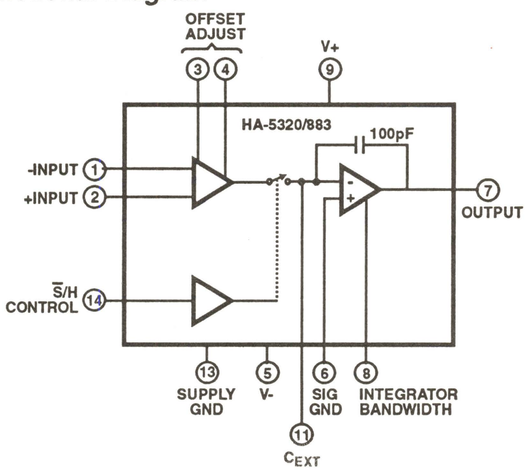

HA-5320/883 (CLCC)
TOP VIEW




### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5320/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5320/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Functional Diagram






CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.



Spec Number 511096-883
File Number 2927.3

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 40V
Differential Input Voltage............................... 24V
Digital Input Voltage (S/H Pin) ......................+8V, -15V
Output Current, Continuous (Note 1) ....................±20mA
Storage Temperature Range ................. -65°C to +150°C
Junction Temperature.............................. +175°C
Lead Temperature (Soldering 10s)................... +300°C
ESD Classification .............................. <2000V

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 66°C/W | 16°C/W |
| Ceramic LCC Package | 57°C/W | 9°C/W |

Package Power Dissipation at +75°C
CerDip Package........................................1.5W
Ceramic LCC Package ..............................1.75W
Package Power Dissipation Derating Factor Above +75°C
CerDip Package................................ 15mW/°C
Ceramic LCC Package ........................ 17mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range.............$-55°C \le T_A \le +125°C$
Operating Supply Voltage ($\pm V_S$).......................... ±15V
Analog Input Voltage .................................. ±10V
Logic Level Low ($V_{IL}$)..............................0V to 0.8V
Logic Level High ($V_{IH}$) ......................... 2.0V to 5.0V

### TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: V+ = +15V; V- = -15V; $V_{IL}$ = 0.8V (Sample); $V_{IH}$ = 2.0V (Hold); $C_H$ = Internal = 100pF; Signal GND = Supply GND, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | | 1 | +25°C | -1 | +1 | mV |
| | | | 2, 3 | +125°C, -55°C | -2 | + 2 | mV |
| Input Bias Current | $+I_B$ | | 1 | +25°C | -200 | +200 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | +200 | nA |
| | $-I_B$ | | 1 | +25°C | -200 | +200 | nA |
| | | | 2, 3 | +125°C, -55°C | -200 | +200 | nA |
| Input Offset Current | $I_{IO}$ | | 1 | +25°C | -100 | +100 | nA |
| | | | 2, 3 | +125°C, -55°C | -100 | +100 | nA |
| Open Loop Voltage Gain | $+A_{VS}$ | $R_L = 1k\Omega$, $V_{OUT}$ = +10V | 1 | +25°C | 120 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| | $-A_{VS}$ | $R_L = 1k\Omega$, $V_{OUT}$ = -10V | 1 | +25°C | 120 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 110 | - | dB |
| Common Mode Rejection Ratio | +CMRR | V+ = 10V, V- = -20V, $V_{OUT}$ = -5V, $V_{S/H}$ = -4.2V, $V_{GND}$ = -5V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -CMRR | V+ = 20V, V- = -10V, $V_{OUT}$ = +5V, $V_{S/H}$ = 5.8V, $V_{GND}$ = +5V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| Output Current | $+I_O$ | $V_{OUT}$ = +10V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_O$ | $V_{OUT}$ = -10V | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: V+ = +15V; V- = -15V; $V_{IL}$ = 0.8V (Sample); $V_{IH}$ = 2.0V (Hold); $C_H$ = Internal = 100pF; Signal GND = Supply GND, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Output Voltage Swing | $+V_{OP}$ | $R_L$ = 1kΩ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OP}$ | $R_L$ = 1kΩ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 13 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 13 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -13 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -13 | - | mA |
| Power Supply Rejection Ratio | +PSRR | V+ = 14.5V, 15.5V<br>V- = -15V, -15V | 1 | +25°C | 80 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 80 | - | dB |
| | -PSRR | V+ = +15V, +15V,<br>V- = -14.5V, -15.5V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Digital Input Current | $I_{INL}$ | $V_{IN}$ = 0V | 1 | +25°C | - | 4 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 10 | µA |
| | $I_{INH}$ | $V_{IN}$ = 5V | 1 | +25°C | - | 0.1 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 0.1 | µA |
| Digital Input Voltage | $V_{IL}$ | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| | $V_{IH}$ | | 1 | +25°C | 2.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.0 | - | V |
| Output Voltage Droop Rate | $V_D$ | $V_{OUT}$ = 0V | 2 | +125°C | - | 100 | µV/µs |

NOTE:

1. Internal power dissipation may limit output current below 20mA.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Hold Mode Feedthrough | $V_{HMF}$ | $V_{IN}$ = 10$V_{P-P}$, 100kHz | 1 | +25°C | - | 3 | mV |
| Hold Step Error | $V_{ERROR}$ | $V_{IH}$ = 3.5V, $V_{IL}$ = 0V, $T_{RISE}$ ($V_{IL}$ to $V_{IH}$) = 10ns | 1 | +25°C | -11 | 11 | mV |
| Sample Mode Noise Voltage | $E_{N(SAMPLE)}$ | DC to 10MHz, $V_{S/H}$ = 0V, $R_{LOAD}$ = 2kΩ | 1 | +25°C | - | 200 | $\mu V_{RMS}$ |
| Hold Mode Noise Voltage | $E_{N(HOLD)}$ | DC to 10MHz, $V_{S/H}$ = 5V, $R_{LOAD}$ = 2kΩ | 1 | +25°C | - | 200 | $\mu V_{RMS}$ |
| Input Capacitance | $C_{IN}$ | $V_{S/H}$ = 0V | 1 | +25°C | - | 5 | pF |
| Input Resistance | $R_{IN}$ | $V_{S/H}$ = 0V, Delta $V_{IN}$ = 20V | 1 | +25°C | 1 | - | MΩ |
| Slew Rate | +SR | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = -5V to +5V Step 10%, 90% pts | 1 | +25°C | 30 | - | V/µs |
| | -SR | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = +5V to -5V Step 10%, 90% pts | 1 | +25°C | 30 | - | V/µs |
| Rise and Fall Times | $T_R$ | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = 0V to +200mV Step 10%, 90% pts | 1 | +25°C | - | 150 | ns |
| | $T_F$ | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = 0V to -200mV Step 10%, 90% pts | 1 | +25°C | - | 150 | ns |
| Overshoot | +OS | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = 0V to +200mV Step | 1 | +25°C | - | 25 | % |
| | -OS | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = 0V to -200mV Step | 1 | +25°C | - | 25 | % |
| 0.1% Acquisition Time | $T_{ACQ}$ 0.1% | $C_L$ = 50pF, $R_L$ = 2kΩ, $V_{OUT}$ = 0V to 10V Step | 1 | +25°C | - | 1.2 | µs |

NOTE:

1. The parameters listed in this table are controlled via design or process parameters and are not directly tested. These parameters are characterized upon initial design release and upon design changes which would affect these characteristics.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | - |
| Final Electrical Test Parameters | 1(Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

## Die Characteristics

**DIE DIMENSIONS:**
92 x 152 x 19 ± 1mils

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

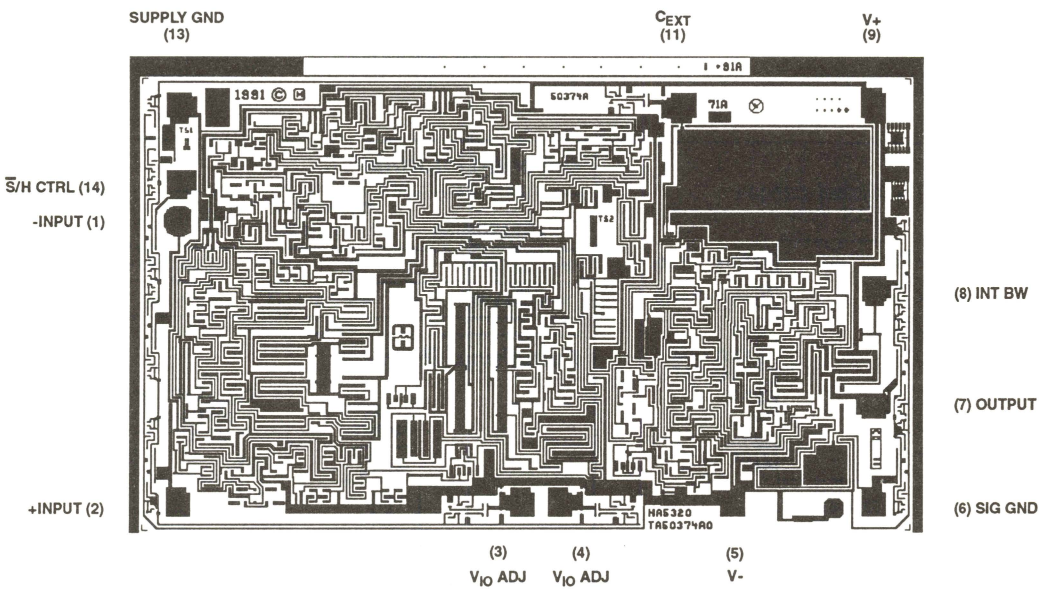
**WORST CASE CURRENT DENSITY:**
$1.742 \times 10^5$ A/cm$^2$

**TRANSISTOR COUNT:** 184

**SUBSTRATE POTENTIAL:** V-

## Metallization Mask Layout

HA-5320/883



HARRIS SEMICONDUCTOR

# HA-5340/883

## High Speed, Low Distortion, Precision Monolithic Sample and Hold Amplifier

June 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Fast Acquisition Time (0.01%) . . . . . . . . . . . . . . . 900ns
- Fast Hold Mode Settling Time (0.01%). . . . . . . . . 300ns
- Low Distortion (Hold Mode) . . . . . . . . . . . -72dBc (Typ) ($V_{IN}$ = 200kHz, Fs = 450kHz, $5V_{P-P}$)
- Bandwidth Minimally Affected By External $C_H$
- Fully Differential Analog Inputs
- Built-in 135pF Hold Capacitor
- Pin Compatible with HA-5320

### Applications

- High Bandwidth Precision Data Acquisition Systems
- Inertial Navigation and Guidance Systems
- Ultrasonics
- SONAR
- RADAR

### Description

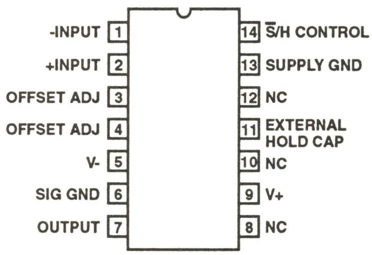
The HA-5340/883 combines the advantages of two sample/hold architectures to create a new generation of monolithic sample/hold. High amplitude, high frequency signals can be sampled with very low distortion being introduced. The combination of exceptionally fast acquisition time and specified/characterized hold mode distortion is an industry first. Additionally, the AC performance is only minimally affected by additional hold capacitance.

To achieve this level of performance, the benefits of an integrating output stage have been combined with the advantages of a buffered hold capacitor. To the user this translates to a front-end stage that has high bandwidth due to charging only a small capacitive load and an output stage with constant pedestal error which can be nulled out using the offset adjust pins. Since the performance penalty for additional hold capacitance is low, the designer can further minimize pedestal error and droop rate without sacrificing speed.

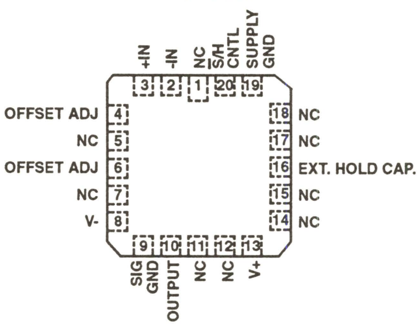
Low distortion, fast acquisition, and low droop rate are the result, making the HA-5340/883 the obvious choice for high speed, high accuracy sampling systems.

### Pinouts

HA-5340/883 (CERDIP)
TOP VIEW



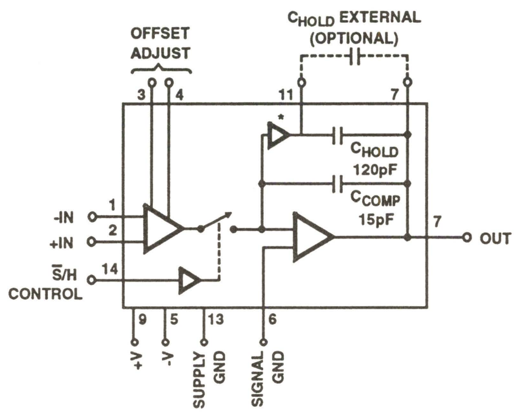

HA-5340/883 (CLCC)
TOP VIEW




### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-5340/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5340/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

### Functional Diagram




NOTE: Buffer acts as a buffer in sample mode, acts as a closed switch in hold mode.





Spec Number 511117-883
File Number 2452.1

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .................... 36V
Differential Input Voltage................................ 24V
Digital Input Voltage (S/H Pin) .......................+8V, -6V
Output Current, Continuous ............................±20mA
Storage Temperature Range ................. -65°C to +150°C
Junction Temperature............................ +175°C
Lead Temperature (Soldering 10s)................... +300°C
ESD Classification ............................... <2000V

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 68°C/W | 17°C/W |
| Ceramic LCC Package | 68°C/W | 18°C/W |

Package Power Dissipation at +75°C
CerDip Package.................................. 1.5W
Ceramic LCC Package ............................ 1.5W
Package Power Dissipation Derating Factor Above +75°C
CerDip Package............................... 15mW/°C
Ceramic LCC Package ......................... 15mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range............ -55°C $\leq T_A \leq$ +125°C
Operating Supply Voltage ($\pm V_S$)......................... ±15V
Analog Input Voltage ................................. ±10V
Logic Level Low ($V_{IL}$)............................0V to 0.8V
Logic Level High ($V_{IH}$) ......................... 2.0V to 5.0V

**TABLE 1. DC ELECTICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V+ = +15V; V- = -15V; $V_{IL}$ = 0.8V (Sample); $V_{IH}$ = 2.0V (Hold); $C_H$ = Internal = 135pF; Signal GND = Supply GND, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | | 1 | +25°C | -1.5 | 1.5 | mV |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | mV |
| Input Bias Current | $+I_B$ | | 1 | +25°C | -350 | 350 | nA |
| | | | 2, 3 | +125°C, -55°C | -350 | 350 | nA |
| | $-I_B$ | | 1 | +25°C | -350 | 350 | nA |
| | | | 2, 3 | +125°C, -55°C | -350 | 350 | nA |
| Input Offset Current | $I_{IO}$ | | 1 | +25°C | -350 | 350 | nA |
| | | | 2, 3 | +125°C, -55°C | -350 | 350 | nA |
| Open Loop Voltage Gain | $+A_{VS}$ | $R_L$ = 2kΩ, $C_L$ = 60pF, $V_{OUT}$ = +10V | 1 | +25°C | 110 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 100 | - | dB |
| | $-A_{VS}$ | $R_L$ = 2kΩ, $C_L$ = 60pF, $V_{OUT}$ = -10V | 1 | +25°C | 110 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 100 | - | dB |
| Common Mode Rejection Ratio | +CMRR | V+ = 5V, V- = -25V, $V_{OUT}$ = -10V, $V_{\overline{S}/H}$ = -9.2V | 1 | +25°C | 72 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 72 | - | dB |
| | -CMRR | V+ = 25V, V- = -5V, $V_{OUT}$ = +10V, $V_{\overline{S}/H}$ = 10.8V | 1 | +25°C | 72 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 72 | - | dB |
| Output Current | $+I_O$ | $V_{OUT}$ = +10V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | $-I_O$ | $V_{OUT}$ = -10V | 1 | +25°C | -10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -10 | - | mA |
| Output Voltage Swing | $+V_{OP}$ | $R_L$ = 2kΩ, $C_L$ = 60pF | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | $-V_{OP}$ | $R_L$ = 2kΩ, $C_L$ = 60pF | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |



CAUTION: These devices are sensitive to electronic discharge. Proper IC handling procedures should be followed.

**TABLE 1. DC ELECTICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: V+ = +15V; V- = -15V; $V_{IL}$ = 0.8V (Sample); $V_{IH}$ = 2.0V (Hold); $C_H$ = Internal = 135pF; Signal GND = Supply GND, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Power Supply Current | $+I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | - | 25 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 25 | mA |
| | $-I_{CC}$ | $V_{OUT}$ = 0V, $I_{OUT}$ = 0mA | 1 | +25°C | -25 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -25 | - | mA |
| Power Supply Rejection Ratio | +PSRR | V+ = 13.5V, 16.5V V- = -15V, -15V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| | -PSRR | V+ = +15V, +15V, V- = -13.5V, -16.5V | 1 | +25°C | 75 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 75 | - | dB |
| Digital Input Current | $I_{INL}$ | $V_{IN}$ = 0V | 1 | +25°C | - | 40 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 40 | µA |
| | $I_{INH}$ | $V_{IN}$ = 5V | 1 | +25°C | - | 40 | µA |
| | | | 2, 3 | +125°C, -55°C | - | 40 | µA |
| Digital Input Voltage | $V_{IL}$ | | 1 | +25°C | - | 0.8 | V |
| | | | 2, 3 | +125°C, -55°C | - | 0.8 | V |
| | $V_{IH}$ | | 1 | +25°C | 2.0 | - | V |
| | | | 2, 3 | +125°C, -55°C | 2.0 | - | V |
| Output Voltage Droop Rate | $V_D$ | $V_{OUT}$ = 0V | 2 | +125°C | - | 95 | µV/µs |

**TABLE 2. AC ELECTICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V+ = +15V; V- = -15V; $V_{IL}$ = 0.8V (Sample); $V_{IH}$ = 2.0V (Hold); $C_H$ = Internal = 135pF; - Input Tied to Output, Signal GND = Supply GND, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUP | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Hold Step Error | $V_{ERROR}$ | $V_{IL}$ = 0V, $V_{IH}$ = 4.0V, $t_{RISE}(V_{S/H})$ = 15ns | 4 | +25°C | -50 | 50 | mV |
| Rise Time & Fall Time | $T_R$ | $C_L$=60pF, $R_L$=2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to +200mV Step 10%, 90%pts | 4 | +25°C | - | 50 | ns |
| | | | 5, 6 | +125°C, -55°C | - | 50 | ns |
| | $T_F$ | $C_L$ = 60pF, $R_L$ = 2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to -200mV Step 10%, 90%pts | 4 | +25°C | - | 50 | ns |
| Overshoot | +OS | $C_L$ = 60pF, $R_L$ = 2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to +200mV Step | 4 | +25°C | - | 60 | % |
| | | | 5, 6 | +125°C, -55°C | - | 60 | % |
| | -OS | $C_L$ = 60pF, $R_L$ = 2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to -200mV Step | 4 | +25°C | - | 60 | % |
| | | | 5, 6 | +125°C, -55°C | - | 60 | % |
| Slew Rate | +SR | $C_L$ = 60pF, $R_L$ = 2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to +10V Step, 25%, 75% pts | 4 | +25°C | 40 | - | V/µs |
| | | | 5, 6 | +125°C, -55°C | 40 | - | V/µs |
| | -SR | $C_L$ = 60pF, $R_L$ = 2kΩ, $A_V$ = +1, $V_{OUT}$ = 0V to -10V Step, 25%, 75% pts | 4 | +25°C | 40 | - | V/µs |
| | | | 5, 6 | +125°C, -55°C | 40 | - | V/µs |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Hold Mode Feedthrough | $V_{HMF}$ | $V_{IN} = 20V_{P-P}$, 200kHz | 1 | +25°C | - | -70 | dB |
| Sample Mode Noise Voltage | $E_{n(SAMPLE)}$ | DC to 10MHz, $V_{S/H} = 0V$, $R_{LOAD} = 2K$ | 1 | +25°C | - | 335 | $\mu V_{RMS}$ |
| Hold Mode Noise Voltage | $E_{n(HOLD)}$ | DC to 10MHz, $V_{S/H} = 5V$, $R_{LOAD} = 2K$ | 1 | +25°C | - | 100 | $\mu V_{RMS}$ |
| Input Capacitance | $C_{IN}$ | $V_{S/H} = 0V$ | 1 | +25°C | - | 5 | pF |
| Input Resistance | $R_{IN}$ | $V_{S/H} = 0V$, Delta $V_{IN} = 20V$ | 1 | +25°C | 1 | - | MΩ |
| 0.1% Acquisition Time | $T_{ACQ}$ 0.1% | $C_L = 60pF$, $R_L = 2K$, $V_{OUT} = 0V$ to 10V Step | 1 | +25°C | - | 600 | ns |
| Total Harmonic Distortion Hold Mode | $THD_{200K(HOLD)}$ | $F_S = 450kHz$, $V_{IN} = 20V_{P-P}$, 200kHz | 1 | +25°C | - | -50 | dBc |
| | $THD_{500K(HOLD)}$ | $F_S = 450kHz$, $V_{IN} = 5V_{P-P}$, 500kHz | 1 | +25°C | - | -47 | dBc |
| Total Harmonic Distortion Sample Mode | $THD_{200K(SAMPLE)}$ | $V_{IN} = 20V_{P-P}$, 200kHz | 1 | +25°C | - | -60 | dBc |
| | $THD_{500K(SAMPLE)}$ | $V_{IN} = 5V_{P-P}$, 500kHz | 1 | +25°C | - | -49 | dBc |

NOTE:

1. The parameters listed in this table are controlled via design or process parameters and are not directly tested. These parameters are characterized upon initial design release and upon design changes which would affect these characteristics.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | - |
| Final Electrical Test Parameters | 1(Note 1), 2, 3, 4, 5, 6 |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

## Die Characteristics

**DIE DIMENSIONS:**
84 x 139 x 19mils

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

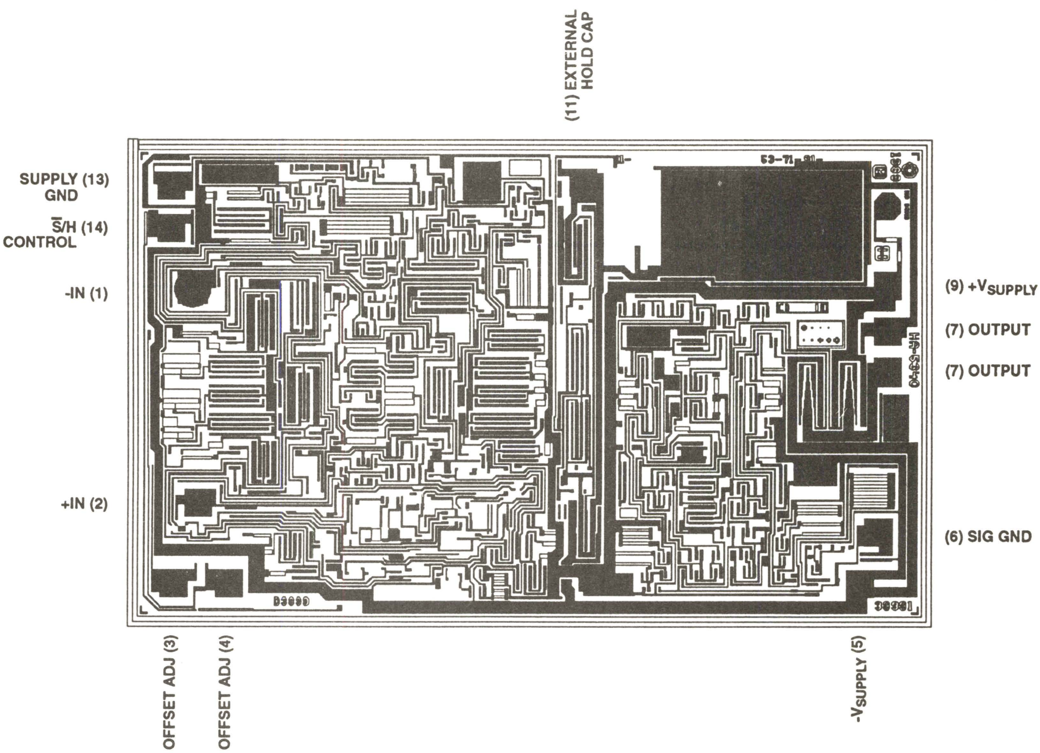
**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos)
Silox Thickness: 12kÅ ± 2.0kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**DIE ATTACH:**
Material: Gold Silicon Eutectic Alloy
Temperature:Ceramic DIP - 460°C (Max)
Ceramic LCC - 420°C (Max)

**WORST CASE CURRENT DENSITY:**
$5.33 \times 10^4$ A/cm$^2$

## Metallization Mask Layout

HA-5340/883



# HA-5351/883

## ADVANCE INFORMATION

June 1994

## Fast Acquisition, Low Power Sample and Hold Amplifier

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Fast Acquisition to 0.01% . . . . . . . . . . . . . . . 70ns (Max)**
- **Low Offset Error . . . . . . . . . . . . . . . . . . . . . . . ±2mV (Max)**
- **Low Pedestal Error . . . . . . . . . . . . . . . . . . . . . ±8mV (Max)**
- **Low Droop Rate . . . . . . . . . . . . . . . . . . . . . 2µV/µs (Max)**
- **Wide Unity Gain Bandwidth . . . . . . . . . . . 40MHz (Typ)**
- **Low Power Dissipation . . . . . . . . . . . . . . . 220mW (Max)**
- **Total Harmonic Distortion (Hold Mode) . . -72dBc (Typ) ($V_{IN}$ = $5V_{P-P}$ at 1 MHz)**
- **Fully Differential Inputs**
- **On Board Hold Capacitor**

### Applications

- **Synchronous Sampling**
- **Wide Bandwidth A/D Conversion**
- **Deglitching**
- **Peak Detection**
- **High Speed DC Restore**

### Description

The HA-5351/883 is a fast acquisition, wide bandwidth sample/hold amplifier built with the Harris HBC-10 BiCMOS process. This sample and hold amplifier offers the combination of features; fast acquisition time (70ns to 0.01% maximum), excellent DC precision and extremely low power dissipation, making it ideal for use in systems that sample multiple signals and require low power. In systems with multiple channels also consider the Dual HA-5352/883 sample and hold amplifier.

The HA-5351/883 is in an open loop configuration with fully differential inputs providing flexibility for user defined feedback. In unity gain the HA-5351/883 is completely self-contained and requires no external components. The on-board 15pF hold capacitor is completely isolated to minimizing droop rate and reduce sensitivity to pedestal error. The HA5351/883 is available in 8 lead CerDIP for minimum board space and easy layout.

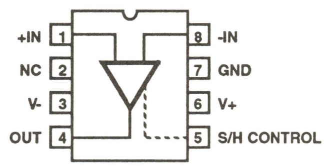
### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA-5351MJ/883 | -55°C to +125°C | 8 Lead CerDIP |



### Pinout

**HA-5351/883**
**(CERDIP)**
TOP VIEW








Spec Number 511118-883
File Number 3727

HARRIS SEMICONDUCTOR

# HA-5352/883

## ADVANCE INFORMATION

June 1994

## Fast Acquisition Dual Sample and Hold Amplifier

### Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Fast Acquisition to 0.01% . . . . . . . . . . . . . . .70ns (Max)**
- **Low Offset Error . . . . . . . . . . . . . . . . . . . . . . . .±2mV (Max)**
- **Low Pedestal Error . . . . . . . . . . . . . . . . . . . . . .±8mV (Max)**
- **Low Droop Rate . . . . . . . . . . . . . . . . . . . . . 2µV/µs (Max)**
- **Wide Unity Gain Bandwidth . . . . . . . . . . . 40MHz (Typ)**
- **Low Power Dissipation per Amp . . . . . . 220mW (Max)**
- **Total Harmonic Distortion (Hold Mode) . . -72dBc (Typ) ($V_{IN} = 5V_{P-P}$ at 1MHz)**
- **Fully Differential Inputs**
- **On Board Hold Capacitor**

### Applications

- **Synchronous Sampling**
- **Wide Bandwidth A/D Conversion**
- **Deglitching**
- **Peak Detection**
- **High Speed DC Restore**

### Description

The HA-5352/883 is a fast acquisition, wide bandwidth Dual Sample and Hold amplifier built with the Harris HBC-10 BiCMOS process. This Sample and Hold amplifier offers the combination of features; fast acquisition time (70ns to 0.01%), excellent DC precision and extremely low power dissipation, making it ideal for use in multi-channel systems that require low power.

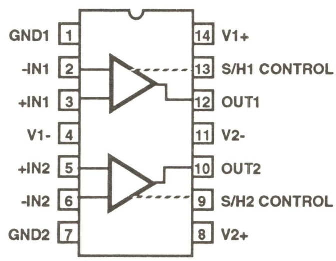
The HA-5352/883 comes in an open loop configuration with fully differential inputs providing flexibility for user defined feedback. In unity gain the HA-5352/883 is completely self-contained and requires no external components. The on-board 15pF hold capacitors are completely isolated to minimize droop rate and reduce the sensitivity of pedestal error. The HA-5352/883 Dual Sample and Hold is available in a 14 lead CerDIP package saving board space while its pinout is designed to simplify layout.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA5352MJ/883 | -55°C to +125°C | 14 Lead CerDIP |

### Pinout

**HA-5352/883**
**(CERDIP)**
TOP VIEW








Spec Number 511119-883
File Number 3728

# ANALOG 8

## ANALOG MULTIPLIERS

PAGE

ANALOG MULTIPLIER DATA SHEETS

HARRIS SEMICONDUCTOR

# HA-2546/883

## Wideband Two Quadrant Analog Multiplier (Voltage Output)

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Speed Voltage Output. . . . . . . . . . . 300V/μs (Min)
- Low Multiplication Error . . . . . . . . . . . . . . . .3.0% (Max) 1.6% (Typ)
- Input Bias Currents . . . . . . . . . . . . . . . . . . . . 5μA (Max) 1.2μA (Typ)
- Signal Input Feedthrough . . . . . . . . . . . . . .-52dB (Typ)
- Wide Signal Bandwidth. . . . . . . . . . . . . . . . 30MHz (Typ)
- Wide Control Bandwidth . . . . . . . . . . . . . . 17MHz (Typ)
- Gain Flatness to 5MHz. . . . . . . . . . . . . . . .0.10dB (Typ)

### Applications

- Military Avionics
- Missile Guidance Systems
- Medical Imaging Displays
- Video Mixers
- Sonar AGC Processors
- Radar Signal Conditioning
- Voltage Controlled Amplifier
- Vector Generator

### Description

The HA-2546/883 is a monolithic, high speed, two quadrant, analog multiplier constructed in the Harris Dielectrically Isolated High Frequency Process. The HA-2546/883 has a voltage output with a 30MHz signal bandwidth, 300V/μs slew rate and a 17MHz control input bandwidth. High bandwidth and slew rate make this part an ideal component for use in video systems. The suitability for precision video applications is demonstrated further by the 0.1dB gain flatness at 5MHz, 1.6% multiplication error, -52dB feedthrough and differential inputs with 1.2μA bias currents. The HA-2546/883 also has low differential gain (0.1% typ.) and phase (0.1° typ.) errors.

The HA-2546/883 is well suited for AGC circuits as well as mixer applications for sonar, radar, and medical imaging equipment. The voltage output of the HA-2546/883 simplifies many designs by eliminating the current-to-voltage conversion stage required for current output multipliers.

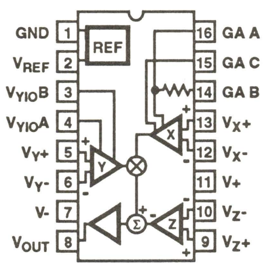
### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2546/883 | -55°C to +125°C | 16 Lead CerDIP |
| HA4-2546/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

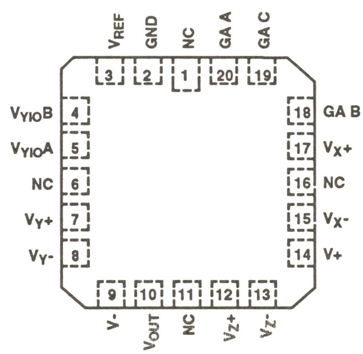


### Pinouts

HA-2546/883 (CERDIP) TOP VIEW




HA-2546/883 (CLCC) TOP VIEW



## Absolute Maximum Ratings

Voltage Between V+ and V- .... 35V
Differential Input Voltage.... 6V
Output Current .... 60mA
Junction Temperature.... +175°C
Storage Temperature Range .... $-65^oC \le T_A \le +150^oC$
ESD Rating.... <2000V
Lead Temperature (Soldering 10s).... +300°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 80°C/W | 25°C/W |
| Ceramic LCC | 61°C/W | 12°C/W |

Maximum Package Power Dissipation
CerDIP Package at +75°C.... 1.25W
Ceramic LCC Package at +75°C.... 1.64W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package .... 12mW/°C
Ceramic LCC Package .... 16mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Temperature Range.... -55°C to +125°C
Operating Supply Voltage.... ±8V to ±15V

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 50pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Multiplication Error | ME | $V_Y$ = ±5V | 1 | +25°C | -3 | 3 | %FS |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | %FS |
| Scale Factor Error | SF | | 1 | +25°C | -5 | 5 | % |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | % |
| Common Mode Range | +CMR | | 1 | +25°C | 5 | - | V |
| | | | 2, 3 | +125°C, -55°C | 5 | - | V |
| | -CMR | | 1 | +25°C | - | -5 | V |
| | | | 2, 3 | +125°C, -55°C | - | -5 | V |
| Input Offset Voltage ($V_Y$) | $V_{IO}(V_Y)$ | $V_{CM}$ = 0V | 1 | +25°C | -10 | 10 | mV |
| | | | 2, 3 | +125°C, -55°C | -15 | 15 | mV |
| Input Bias Current ($V_Y$) | $I_B(V_Y)$ | $V_{CM}$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -20 | 20 | µA |
| Input Offset Current ($V_Y$) | $I_{IO}(V_Y)$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Common Mode ($V_Y$) Rejection Ratio | +CMRR($V_Y$) | $V_Y$ = 0 to +5V, $V_X$ = +2V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 60 | - | dB |
| | -CMRR($V_Y$) | $V_Y$ = 0 to -5V, $V_X$ = +2V | 1 | +25°C | 60 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 60 | - | dB |
| Input Offset Voltage ($V_X$) | $V_{IO}(V_X)$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | mV |
| | | | 2, 3 | +125°C, -55°C | -15 | 15 | mV |
| Input Bias Current ($V_X$) | $I_B(V_X)$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | µA |
| Input Offset Current ($V_X$) | $I_{IO}(V_X)$ | $V_{CM}$ = 0V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Input Offset Voltage ($V_Z$) | $V_{IO}(V_Z)$ | $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -15 | 15 | mV |
| Output Voltage Swing | $+V_{OUT}$ | $V_Y$ = +5V, $V_X$ = +2.5V | 1 | +25°C | 5 | - | V |
| | | | 2, 3 | +125°C, -55°C | 5 | - | V |
| | $-V_{OUT}$ | $V_Y$ = -5V, $V_X$ = +2.5V | 1 | +25°C | - | -5 | V |
| | | | 2, 3 | +125°C, -55°C | - | -5 | V |
| Output Current | $+I_{OUT}$ | $V_Y$ = +5V, $V_X$ = +2.5V | 1 | +25°C | 20 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 20 | - | mA |
| | $-I_{OUT}$ | $V_Y$ = -5V, $V_X$ = +2.5V | 1 | +25°C | - | -20 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -20 | mA |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Power Supply Rejection Ratio | +PSRR | $\Delta V_S = 3V$, V+ = +15V, V- = -15V, V+ = +12V, V- = -15V | 1 | +25°C | 58 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 58 | - | dB |
| | -PSRR | $\Delta V_S = 3V$, V+ = +15V, V- = -15V, V+ = +15V, V- = -12V | 1 | +25°C | 58 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 58 | - | dB |
| Quiescent Power Supply Current | $+I_{CC}$ | $V_X = V_Y = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | 29 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 29 | - | mA |
| | $-I_{CC}$ | $V_X = V_Y = 0V$, $I_{OUT} = 0mA$ | 1 | +25°C | - | -29 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -29 | mA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $C_{LOAD} = 50pF$, Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Slew Rate | +SR | $V_{OUT}$ = -5V to +5V, $V_X = 2V_{DC}$ | 1 | +25°C | 300 | - | V/µs |
| | | | 1 | +125°C, -55°C | 300 | - | V/µs |
| | -SR | $V_{OUT}$ = +5V to -5V, $V_X = 2V_{DC}$ | 1 | +25°C | 300 | - | V/µs |
| | | | 1 | +125°C, -55°C | 300 | - | V/µs |
| Rise and Fall Time | TR | $V_{OUT}$ = -100mV to +100mV $V_X = 2V_{DC}$ | 1, 3 | +25°C | - | 15 | ns |
| | | | 1, 3 | +125°C, -55°C | - | 17 | ns |
| | TF | $V_{OUT}$ = +100mV to -100mV $V_X = 2V_{DC}$ | 1, 3 | +25°C | - | 15 | ns |
| | | | 1, 3 | +125°C, -55°C | - | 17 | ns |
| Overshoot | +OS | $V_{OUT}$ = -100mV to +100mV $V_X = 2V_{DC}$ | 1 | +25°C | - | 30 | % |
| | | | 1 | +125°C, -55°C | - | 30 | % |
| | -OS | $V_{OUT}$ = +100mV to -100mV $V_X = 2V_{DC}$ | 1 | +25°C | - | 30 | % |
| | | | 1 | +125°C, -55°C | - | 30 | % |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 5V$, $V_X = 2V_{DC}$ | 1, 2 | +25°C | 9.5 | - | MHz |
| | | | 1, 2 | +125°C, -55°C | 9.5 | - | MHz |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/$(2\pi V_{PEAK})$.
3. Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-in) | 1 |
| Final Electrical Test Parameters | 1(Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

8 ANALOG MULTIPLIERS

## Die Characteristics

**DIE DIMENSIONS:**
79.9mils x 119.7mils x 19mils ± 1mils

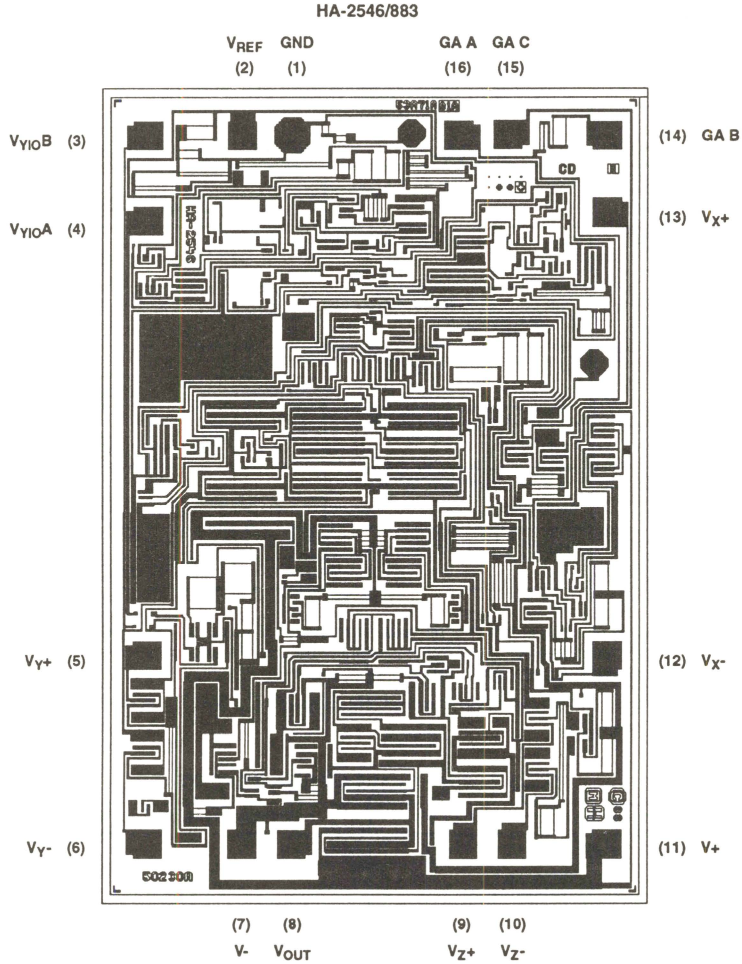
**METALLIZATION:**
Type: Al, 1%Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos)
Silox Thickness: 12kÅ ± 1.5kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.72 \times 10^5$ A/cm$^2$

**TRANSISTOR COUNT:** 87

## Metallization Mask Layout



HARRIS SEMICONDUCTOR

# HA-2556/883

## Wideband Four Quadrant Analog Multiplier (Voltage Output)

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Speed Voltage Output. . . . . . . . . . . . 450V/μs (Typ)
- Low Multiplication error . . . . . . . . . . . . . . . . . 1.5% (Typ)
- Input Bias Currents . . . . . . . . . . . . . . . . . . . . . . 8μA (Typ)
- Signal Input Feedthrough . . . . . . . . . . . . . . -50dB (Typ)
- Wide Y Channel Bandwidth . . . . . . . . . . . . 57MHz (Typ)
- Wide X Channel Bandwidth . . . . . . . . . . . . 52MHz (Typ)
- 0.1dB Gain Flatness ($V_Y$). . . . . . . . . . . . . . . 5.0MHz (Typ)

### Applications

- Military Avionics
- Missile Guidance Systems
- Medical Imaging Displays
- Video Mixers
- Sonar AGC Processors
- Radar Signal Conditioning
- Voltage Controlled Amplifier
- Vector Generator

### Description

The HA-2556/883 is a monolithic, high speed, four quadrant, analog multiplier constructed in Harris' Dielectrically Isolated High Frequency Process. The voltage output simplifies many designs by eliminating the current-to-voltage conversion stage required for current output multipliers. The HA-2556/883 provides a 450V/μs output slew rate and maintains 52MHz and 57MHz bandwidths for the X and Y channels respectively, making it an ideal part for use in video systems.

The suitability for precision video applications is demonstrated further by the Y Channel 0.1dB gain flatness to 5.0MHz, 1.5% multiplication error, -50dB feedthrough and differential inputs with 8μA bias current. The HA-2556 also has low differential gain (0.1%) and phase (0.1°) errors.

The HA-2556/883 is well suited for AGC circuits as well as mixer applications for sonar, radar, and medical imaging equipment. The HA-2556/883 is not limited to multiplication applications only; frequency doubling, power detection, as well as many other configurations are possible.

### Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2556/883 | -55°C to +125°C | 16 Lead CerDIP |

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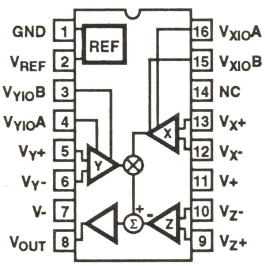
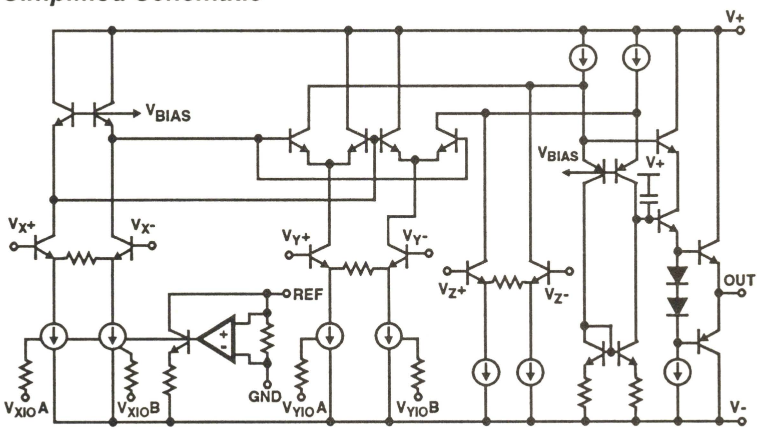
ANALOG MULTIPLIERS

### Pinout

HA-2556/883
(CERDIP)
TOP VIEW




### Simplified Schematic




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

## Absolute Maximum Ratings

Voltage Between V+ and V- . . . . . . . . . . 35V
Differential Input Voltage. . . . . . . . . . 6V
Output Current . . . . . . . . . . ±40mA
ESD Rating. . . . . . . . . . < 2000V
Lead Temperature (Soldering 10s). . . . . . . . . . +300°C
Storage Temperature Range . . . . . . . . . . $-65^oC \leq T_A \leq +150^oC$
Max Junction Temperature . . . . . . . . . . +175°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 82°C/W | 27°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package . . . . . . . . . . 1.22W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package . . . . . . . . . . 12mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$). . . . . . . . . . ±15V
Operating Temperature Range . . . . . . . . . . $-55^oC \leq T_A \leq +125^oC$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_F$ = 50Ω, $R_L$ = 1kΩ, $C_L$ = 20pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Multiplication Error | ME | $V_Y$, $V_X$ = ±5V | 1 | +25°C | -3 | 3 | %FS |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | %FS |
| Linearity Error | LE4V | $V_Y$, $V_X$ = ±4V | 1 | +25°C | -0.5 | 0.5 | %FS |
| | LE5V | $V_Y$, $V_X$ = ±5V | 1 | +25°C | -1 | 1 | %FS |
| Input Offset Voltage ($V_X$) | $V_{XIO}$ | $V_Y$ = ±5V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | mV |
| Input Bias Current ($V_X$) | $I_B$ ($V_X$) | $V_X$ = 0V, $V_Y$ = 5V | 1 | +25°C | -15 | 15 | μA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| Input Offset Current ($V_X$) | $I_{IO}$ ($V_X$) | $V_X$ = 0V, $V_Y$ = 5V | 1 | +25°C | -2 | 2 | μA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | μA |
| Common Mode ($V_X$) Rejection Ratio | CMRR ($V_X$) | $V_XCM$ = ±10V<br>$V_Y$ = 5V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Power Supply ($V_X$) Rejection Ratio | +PSRR ($V_X$) | $V_{CC}$ = +12V to +17V<br>$V_Y$ = 5V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | -PSRR ($V_X$) | $V_{EE}$ = -12V to -17V<br>$V_Y$ = 5V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 45 | - | dB |
| Input Offset Voltage ($V_Y$) | $V_{YIO}$ | $V_X$ = ±5V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | mV |
| Input Bias Current ($V_Y$) | $I_B$ ($V_Y$) | $V_Y$ = 0V, $V_X$ = 5V | 1 | +25°C | -15 | 15 | μA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | μA |
| Input Offset Current ($V_Y$) | $I_{IO}$ ($V_Y$) | $V_Y$ = 0V, $V_X$ = 5V | 1 | +25°C | -2 | 2 | μA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | μA |
| Common Mode ($V_Y$) Rejection Ratio | CMRR ($V_Y$) | $V_YCM$ = +9V, -10V<br>$V_X$ = 5V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Power Supply ($V_Y$) Rejection Ratio | +PSRR ($V_Y$) | $V_{CC}$ = +12V to +17V<br>$V_X$ = 5V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | -PSRR ($V_Y$) | $V_{EE}$ = -12V to -17V<br>$V_X$ = 5V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 45 | - | dB |

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_F$ = 50Ω, $R_L$ = 1kΩ, $C_L$ = 20pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage ($V_Z$) | $V_{ZIO}$ | $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | mV |
| Input Bias Current ($V_Z$) | $I_B$ ($V_Z$) | $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Input Offset Current ($V_Z$) | $I_{IO}$ ($V_Z$) | $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Common Mode ($V_Z$) Rejection Ratio | CMRR ($V_Z$) | $V_ZCM$ = ±10V $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Power Supply ($V_Z$) Rejection Ratio | +PSRR ($V_Z$) | $V_{CC}$ = +12V to +17V $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | -PSRR ($V_Z$) | $V_{EE}$ = -12V to -17V $V_X$ = 0V, $V_Y$ = 0V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 45 | - | dB |
| Output Current | $+I_{OUT}$ | $V_{OUT}$ = 5V, $R_L$ = 250Ω | 1 | +25°C | 20 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 20 | - | mA |
| | $-I_{OUT}$ | $V_{OUT}$ = 5V, $R_L$ = 250Ω | 1 | +25°C | - | -20 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -20 | mA |
| Output Voltage Swing | $+V_{OUT}$ | $R_L$ = 250Ω | 1 | +25°C | 5 | - | V |
| | | | 2, 3 | +125°C, -55°C | 5 | - | V |
| | $-V_{OUT}$ | $R_L$ = 250Ω | 1 | +25°C | - | -5 | V |
| | | | 2, 3 | +125°C, -55°C | - | -5 | V |
| Supply Current | $\pm I_{CC}$ | $V_X$, $V_Y$ = 0V | 1 | +25°C | - | 22 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 22 | mA |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested: at $V_{SUPPLY}$ = ±15V, $R_F$ = 50Ω, $R_L$ = 1kΩ, $C_L$ = 20pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $V_Y$, $V_Z$ CHARACTERISTICS (NOTE 2) | | | | | | | |
| Bandwidth | BW($V_Y$) | -3dB, $V_X$ = 5V, $V_Y \leq$ 200m$V_{P-P}$ | 1 | +25°C | 30 | - | MHz |
| Gain Flatness | GF($V_Y$) | 0.1dB, $V_X$ = 5V, $V_Y \leq$ 200m$V_{P-P}$ | 1 | +25°C | 4.0 | - | MHz |
| AC Feedthrough | $V_{ISO}$ | $f_O$ = 5MHz, $V_Y$ = 200m$V_{P-P}$ $V_X$ = Nulled | 1, 3 | +25°C | - | -45 | dB |
| Rise and Fall Time | $T_R$, $T_F$ | $V_Y$ = 200mV Step, $V_X$ = 5V, 10% to 90% pts | 1 | +25°C | - | 9.5 | ns |
| | | | 1 | +125°C, -55°C | - | 10 | ns |

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ANALOG MULTIPLIERS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested: at $V_{SUPPLY}$ = ±15V, $R_F$ = 50Ω, $R_L$ = 1kΩ, $C_L$ = 20pF, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Overshoot | +OS, -OS | $V_Y$ = 200mV step, $V_X$ = 5V | 1 | +25°C | - | 35 | % |
| | | | 1 | +125°C, -55°C | - | 50 | % |
| Slew Rate | +SR, -SR | $V_Y$ = 10V step, $V_X$ = 5V | 1 | +25°C | 410 | - | V/µs |
| | | | 1 | +125°C, -55°C | 360 | - | V/µs |
| Differential Input Resistance | $R_{IN}$ ($V_Y$) | $V_Y$ = ±5V, $V_X$ = 0V | 1 | +25°C | 650 | - | kΩ |
| $V_X$ CHARACTERISTICS | | | | | | | |
| Bandwidth | BW ($V_X$) | -3dB, $V_Y$ = 5V, $V_X \leq$ 200m$V_{P-P}$ | 1 | +25°C | 30 | - | MHz |
| Gain Flatness | GF ($V_X$) | 0.1dB, $V_Y$ = 5V, $V_X \leq$ 200m$V_{P-P}$ | 1 | +25°C | 2.0 | - | MHz |
| AC Feedthrough | $V_{ISO}$ | $f_O$ = 5MHz, $V_X$ = 200m$V_{P-P}$, $V_Y$ = Nulled | 1, 3 | +25°C | - | -45 | dB |
| Rise & Fall Time | $T_R$, $T_F$ | $V_X$ = 200mV step, $V_Y$ = 5V, 10% to 90% pts | 1 | +25°C | - | 9.5 | ns |
| | | | 1 | +125°C, -55°C | - | 10 | ns |
| Overshoot | +OS, -OS | $V_X$ = 200mV step, $V_Y$ = 5V | 1 | +25°C | - | 35 | % |
| | | | 1 | +125°C, -55°C | - | 50 | % |
| Slew Rate | +SR, -SR | $V_X$ = 10V step, $V_Y$ = 5V | 1 | +25°C | 410 | - | V/µs |
| | | | 1 | +125°C, -55°C | 360 | - | V/µs |
| Differential Input Resistance | $R_{IN}$ ($V_X$) | $V_X$ = ±5V, $V_Y$ = 0V | 1 | +25°C | 650 | - | kΩ |
| OUTPUT CHARACTERISTICS | | | | | | | |
| Output Resistance | $R_{OUT}$ | $V_Y$ = ±5V, $V_X$ = 5V, $R_L$ = 1kΩ to 250Ω | 1 | +25°C | - | 1 | Ω |

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. $V_Z$ AC characteristics may be implied from $V_Y$ due to the use of $V_Z$ as feedback in the test circuit.
3. Offset voltage applied to minimize feedthrough signal.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | - |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

## *Die Characteristics*

**DIE DIMENSIONS:**
71mils x 100mils x 19mils ± 1mils

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

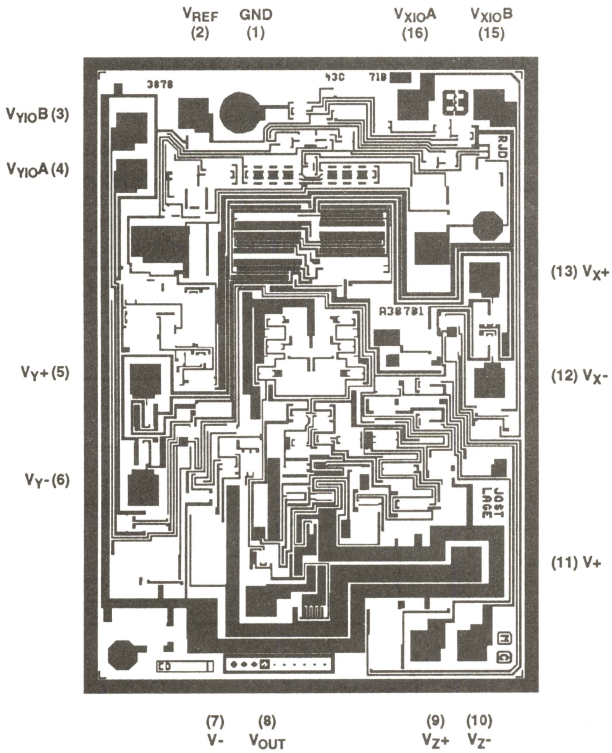
**TRANSISTOR COUNT:** 84

**SUBSTRATE POTENTIAL:** V-

**WORST CASE CURRENT DENSITY:**
$0.47 \times 10^5 A/cm^2$

## *Metallization Mask Layout*

HA-2556/883



# HARRIS SEMICONDUCTOR

# HA-2557/883

## Wideband Four Quadrant Analog Multiplier (Current Output)

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Multiplication Error . . . . . . . . . . . . . . . . 1.5% (Typ)
- Input Bias Currents . . . . . . . . . . . . . . . . . . . . . $8\mu A$ (Typ)
- Signal Input Feedthrough at 5MHz. . . . . . . -52dB (Typ)
- Wide Y Channel Bandwidth . . . . . . . . . . 130MHz (Typ)
- Wide X Channel Bandwidth . . . . . . . . . . . 75MHz (Typ)
- Rise Time ($R_L = 50\Omega$) . . . . . . . . . . . . . . . . . . . 7ns (Typ)
- Supply Current. . . . . . . . . . . . . . . . . . . . . . . 17mA (Max)

### Applications

- Military Avionics
- Missile Guidance Systems
- Medical Imaging Displays
- Video Mixers
- Sonar AGC Processors
- Radar Signal Conditioning
- Voltage Controlled Amplifier
- Vector Generator

### Description

The HA-2557/883 is a monolithic, high speed, four quadrant, analog multiplier constructed in Harris' Dielectrically Isolated High Frequency Process. The single-ended current output of the HA-2557/883 has a 130MHz signal bandwidth ($R_L$ = $50\Omega$). High bandwidth and low distortion make this part an ideal component in video systems.

The suitability for precision video applications is demonstrated further by low multiplication error (1.5%), low feedthrough (-52dB), and differential inputs with low bias currents ($8\mu A$). The HA-2557/883 is also well suited for mixer circuits as well as AGC applications for sonar, radar, and medical imaging equipment.

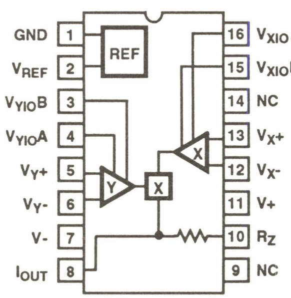
The current output of the HA-2557/883 allows it to achieve higher bandwidths than voltage output multipliers. Full scale output current is trimmed to 1.6mA. An internal $2500\Omega$ feedback resistor is also provided to accurately convert the current, if desired, to a full scale output voltage of ±4V. The HA-2557/883 is not limited to multiplication applications only; frequency doubling, power detection, as well as many other configurations are also possible.

### Ordering Information

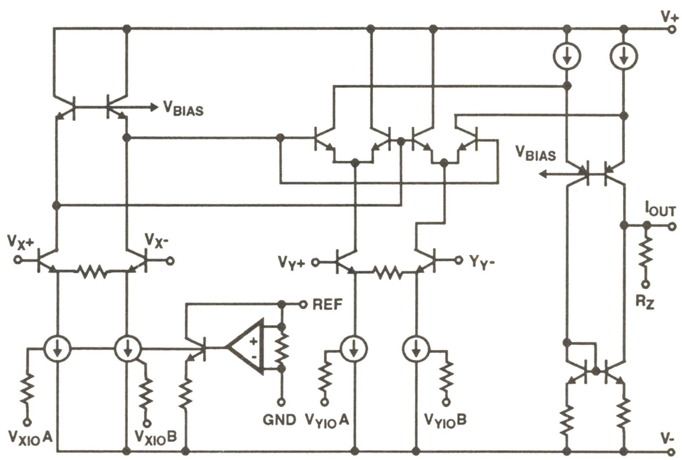
| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|---|---|---|
| HA1-2557/883 | -55°C to +125°C | 16 Lead CerDIP |

### Pinout

HA-2557/883
(CERDIP)
TOP VIEW




### Schematic








Spec Number 511064-883
File Number 3638

## Absolute Maximum Ratings

Voltage Between V+ and V- .................................... 35V
Differential Input Voltage.......................................... 6V
Output Current ............................................... ±3mA
ESD Rating.................................................... < 2000V
Lead Temperature (Soldering 10s) ........................ +300°C
Storage Temperature Range .............. $-65^oC \le T_A \le +150^oC$
Max Junction Temperature ............................... +175°C

## Thermal Information

| Thermal Resistance | $\theta_{JA}$ | $\theta_{JC}$ |
|---|---|---|
| CerDIP Package | 82°C/W | 27°C/W |

Maximum Package Power Dissipation at +75°C
CerDIP Package ............................................. 1.22W
Package Power Dissipation Derating Factor above +75°C
CerDIP Package ............................................. 12mW/°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

## Operating Conditions

Operating Supply Voltage ($\pm V_S$)........................... ±15V
Operating Temperature Range .............. $-55^oC \le T_A \le +125^oC$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_Z$ (Pin 10) not connected, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Multiplication Error | ME | $V_Y$, $V_X$ = ±4V FS = 1.6mA | 1 | +25°C | -3 | 3 | %FS |
| | | | 2, 3 | +125°C, -55°C | -6 | 6 | %FS |
| Linearity Error | LE | $V_Y$, $V_X$ = ±4V | 1 | +25°C | -0.25 | 0.25 | %FS |
| $R_Z$ Accuracy | RZE | Nominal 2500Ω | 1 | +25°C | -3 | 3 | % |
| | | | 2, 3 | +125°C, -55°C | -5 | 5 | % |
| $I_{OUT}$ Offset | $I_{OO}$ | $V_X$, $V_Y$ = 0V | 1 | +25°C | -10 | 10 | µA |
| | | | 2, 3 | +125°C, -55°C | -15 | 15 | µA |
| Input Offset Voltage ($V_X$) | $V_{XIO}$ | $V_Y$ = ±4V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | mV |
| Input Bias Current ($V_X$) | $I_B(V_X)$ | $V_X$ = 0V, $V_Y$ = 4V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Input Offset Current ($V_X$) | $I_{IO}(V_X)$ | $V_X$ = 0V, $V_Y$ = 4V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Common Mode ($V_X$) Rejection Ratio | CMRR($V_X$) | $V_XCM$ = ±10V $V_Y$ = 4V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Power Supply ($V_X$) Rejection Ratio | + PSRR($V_X$) | V+ = +12V to +17V $V_Y$ = 4V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | - PSRR($V_X$) | V- = -12V to -17V $V_Y$ = 4V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 45 | - | dB |
| Input Offset Voltage ($V_Y$) | $V_{YIO}$ | $V_X$ = ±4V | 1 | +25°C | -15 | 15 | mV |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | mV |
| Input Bias Current ($V_Y$) | $I_B(V_Y)$ | $V_Y$ = 0V, $V_X$ = 4V | 1 | +25°C | -15 | 15 | µA |
| | | | 2, 3 | +125°C, -55°C | -25 | 25 | µA |
| Input Offset Current ($V_Y$) | $I_{IO}(V_Y)$ | $V_Y$ = 0V, $V_X$ = 4V | 1 | +25°C | -2 | 2 | µA |
| | | | 2, 3 | +125°C, -55°C | -3 | 3 | µA |
| Common Mode ($V_Y$) Rejection Ratio | CMRR($V_Y$) | $V_YCM$ = +9V, -10V $V_X$ = 4V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| Power Supply ($V_Y$) Rejection Ratio | + PSRR($V_Y$) | V+ = +12V to +17V $V_X$ = 4V | 1 | +25°C | 65 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 65 | - | dB |
| | - PSRR($V_Y$) | V- = -12V to -17V $V_X$ = 4V | 1 | +25°C | 45 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 45 | - | dB |
| Supply Current | $I_{CC}$ | $V_X$, $V_Y$ = 0V | 1 | +25°C | - | 17 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 17 | mA |
| Output Impedance | $Z_{OUT}$ | $V_{OUT}$ = ±10V | 1 | +25°C | 1.0 | - | MΩ |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See AC Specifications in Table 3

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: $V_{SUPPLY}$ = ±15V, $R_Z$ (Pin 10) not connected, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| $V_Y$, CHARACTERISTICS | | | | | | | |
| Bandwidth | $BW(V_Y)$ | -3dB, $V_X$ = 4V, $V_Y \leq$ 200m$V_{P-P}$ | 1 | +25°C | 90 | - | MHz |
| AC Feedthrough | $V_{ISO}$ | $f_O$ = 5MHz, $V_Y$ = 200m$V_{P-P}$ $V_X$ = Nulled | 1, 2 | +25°C | - | -48 | dB |
| Rise and Fall Time | $T_R$, $T_F$ | $V_Y$ = -4V to +4V Step $V_X$ = 4V, 10% to 90% pts | 1 | +25°C | - | 10 | ns |
| Overshoot | +OS, -OS | $V_Y$ = -4V to +4V Step $V_X$ = 4V | 1 | +25°C | - | 10 | % |
| Differential Input Resistance | $R_{IN}(V_Y)$ | $V_Y$ = ±4V, $V_X$ = 0V | 1 | +25°C | 650 | - | kΩ |
| $V_X$ CHARACTERISTICS | | | | | | | |
| Bandwidth | $BW(V_X)$ | -3dB, $V_Y$ = 4V, $V_X \leq$ 200m$V_{P-P}$ | 1 | +25°C | 60 | - | MHz |
| AC Feedthrough | $V_{ISO}$ | $f_O$ = 5MHz, $V_X$ = 200m$V_{P-P}$ $V_Y$ = Nulled | 1, 2 | +25°C | - | -50 | dB |
| Rise and Fall Time | $T_R$, $T_F$ | $V_X$ = -4V to +4V Step $V_Y$ = 4V, 10% to 90% pts | 1 | +25°C | - | 10 | ns |
| Overshoot | +OS, -OS | $V_X$ = -4V to +4V Step $V_Y$ = 4V | 1 | +25°C | - | 15 | % |
| Differential Input Resistance | $R_{IN}(V_X)$ | $V_X$ = ±4V, $V_Y$ = 0V | 1 | +25°C | 650 | - | kΩ |

NOTE:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Offset voltage applied to minimize feedthrough signal.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUPS (SEE TABLE 1) |
|---|---|
| Interim Electrical Parameters (Pre Burn-In) | - |
| Final Electrical Test Parameters | 1 (Note 1), 2, 3 |
| Group A Test Requirements | 1, 2, 3 |
| Groups C and D Endpoints | 1 |

NOTE:

1. PDA applies to Subgroup 1 only.

## Die Characteristics

**DIE DIMENSIONS:**
71mils x 100mils x 19mils ± 1mils

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

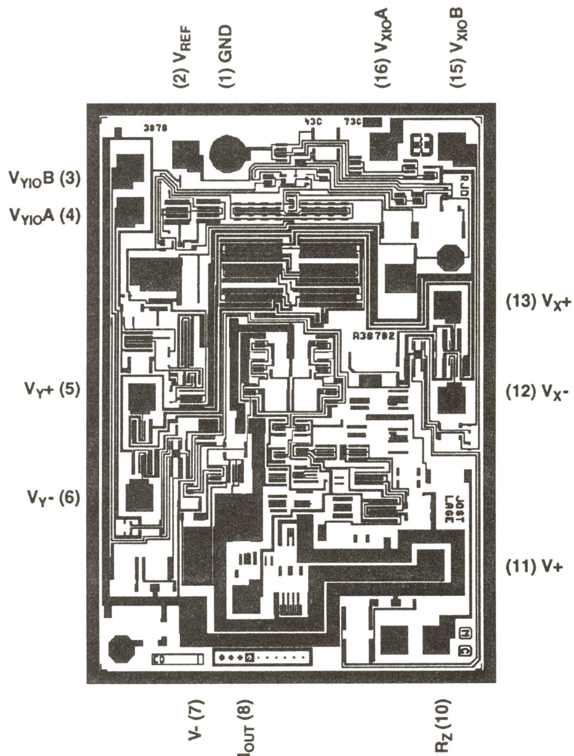
**TRANSISTOR COUNT:** 72

**SUBSTRATE POTENTIAL:** V-

**WORST CASE CURRENT DENSITY:**
0.47 x $10^5$A/cm2

## Metallization Mask Layout

HA-2557/883



# ANALOG 9

## NEW DIE PLOTS



This section contains die characteristics and metallization layouts for those products which have not had electrical specification changes, but have had significant layout changes since the publication of the 1989 "Analog Military Product Data Book". Please refer to AnswerFAX, or the 1989 Analog Military book for complete electrical specifications.

## Die Characteristics

**DIE DIMENSIONS:**
88 x 67 x 19 mils ± 1 mils
2240µm x 1710µm x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.7 \times 10^5 A/cm^2$

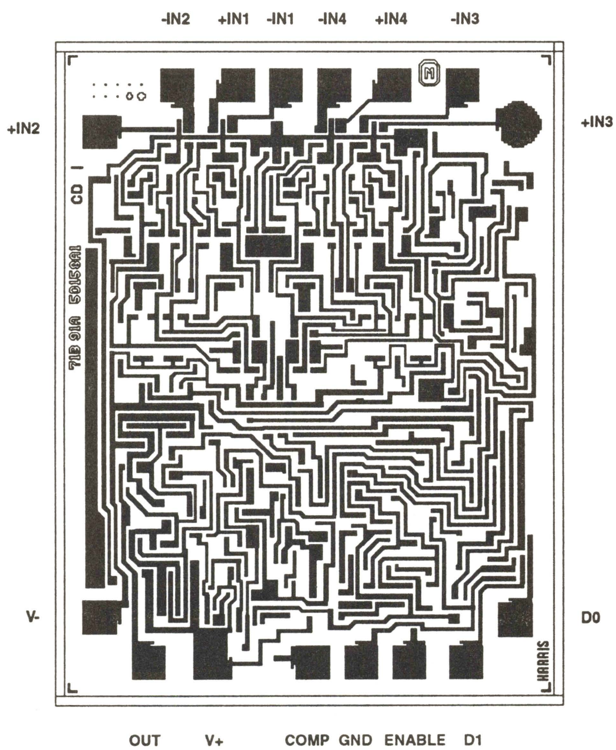
**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

**TRANSISTOR COUNT:** 251

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2400/883




9

NEW DIE PLOTS

## Die Characteristics

**DIE DIMENSIONS:**
102 x 61 x 19 mils ± 1 mils
2590 x 1550 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$6.8 \times 10^4 A/cm^2$

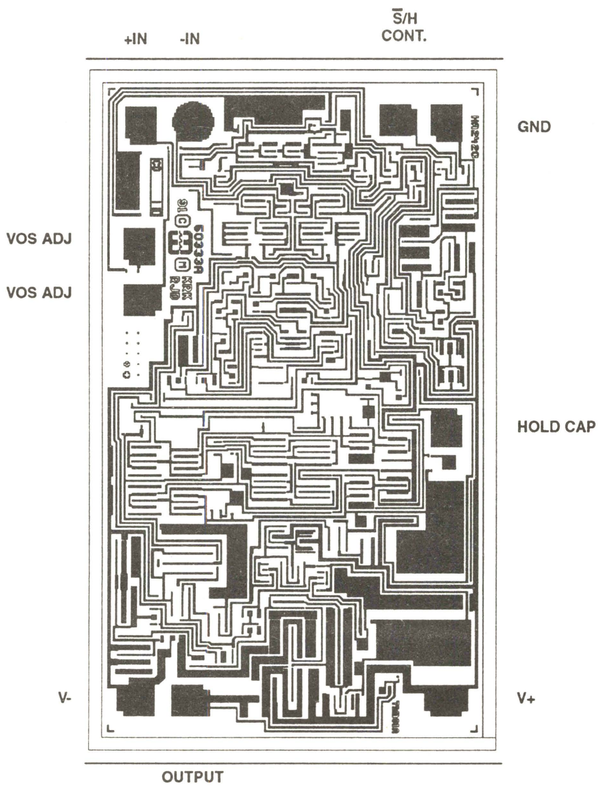
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 78

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2420/883



## Die Characteristics

**DIE DIMENSIONS:**
62 x 76 x 19 mils ± 1 mils
1575 x 1930 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.2 \times 10^5 A/cm^2$

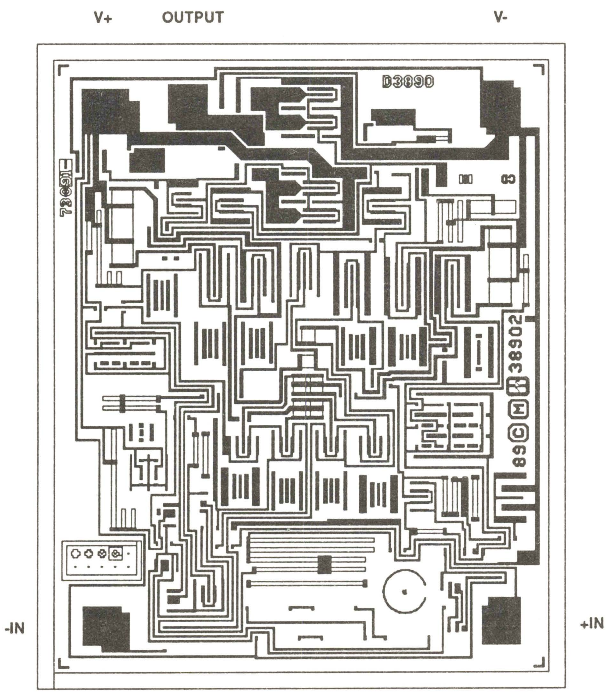
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 30

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2539/883



## Die Characteristics

**DIE DIMENSIONS:**
62 x 76 x 19 mils ± 1 mils
1575 x 1930 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.2 \times 10^5 A/cm^2$

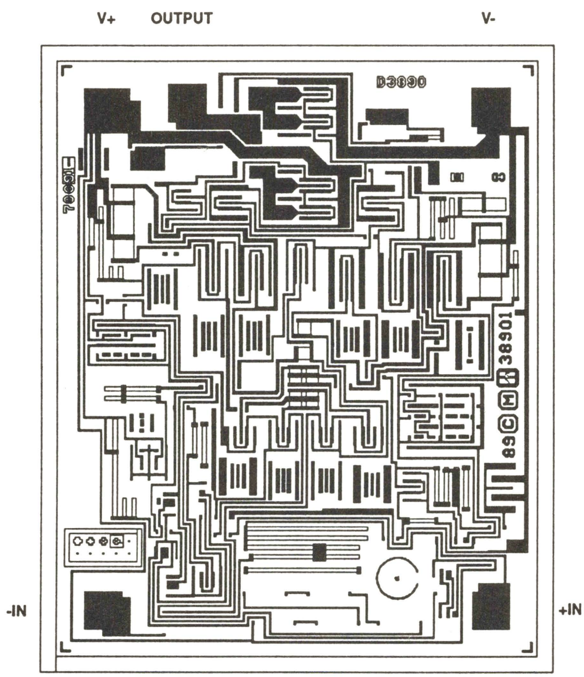
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 30

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2540/883



## *Die Characteristics*

**DIE DIMENSIONS:**
106 x 73 x 19 mils ± 1 mils
2700 x 1850 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
4.0 x $10^4$A/cm$^2$

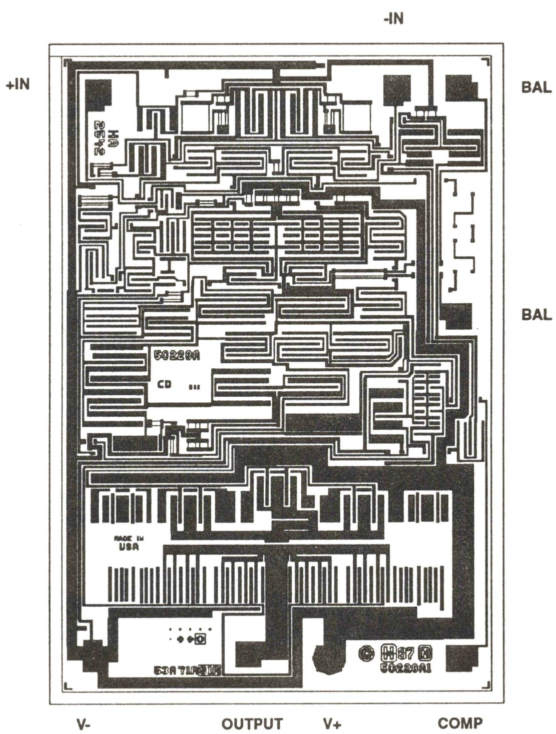
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 43

**PROCESS:** Bipolar Dielectric Isolation

## *Metallization Mask Layout*

HA-2542/883



## Die Characteristics

**DIE DIMENSIONS:**
69 x 56 x 19 mils ± 1 mils
1750 x 1420 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$3.9 \times 10^4 A/cm^2$

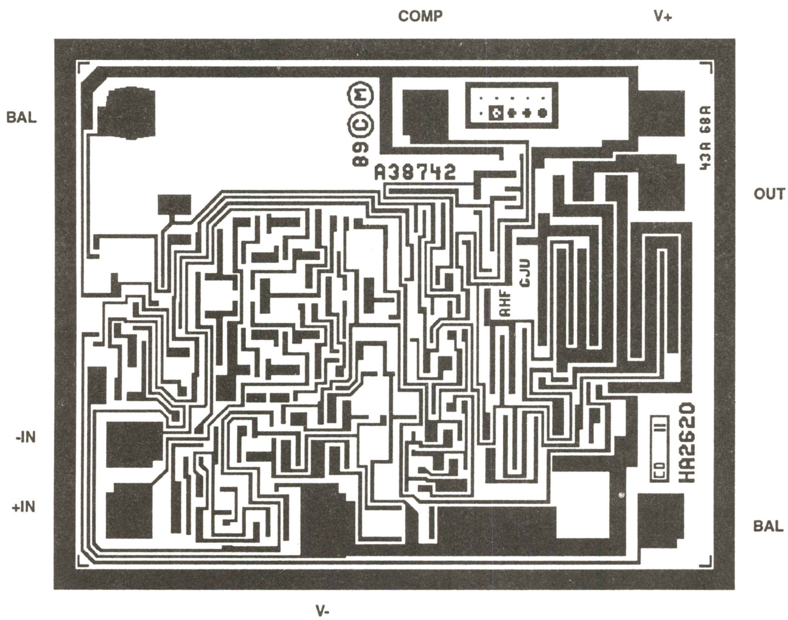
**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

**TRANSISTOR COUNT:**
HA-2620/883: 140
HA-2622/883: 140

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2620/883, HA-2622/883



## Die Characteristics

**DIE DIMENSIONS:**
51 x 67 x 19 mils ± 1 mils
1300 x 1700 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.54 \times 10^5 A/cm^2$

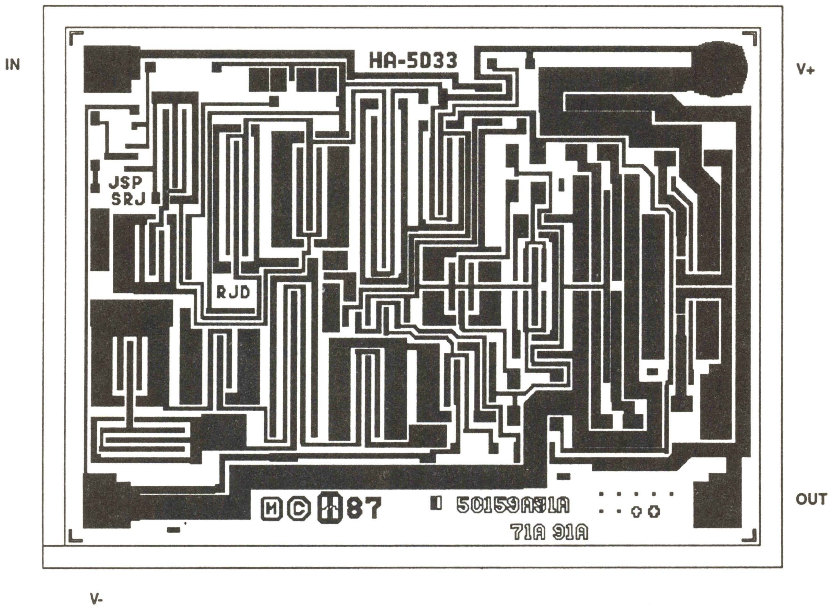
**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

**TRANSISTOR COUNT:** 20

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5033/883



## Die Characteristics

**DIE DIMENSIONS:**
70 x 70 x 19 mils ± 1 mils
1790 x 1780 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.38 \times 10^5 A/cm^2$

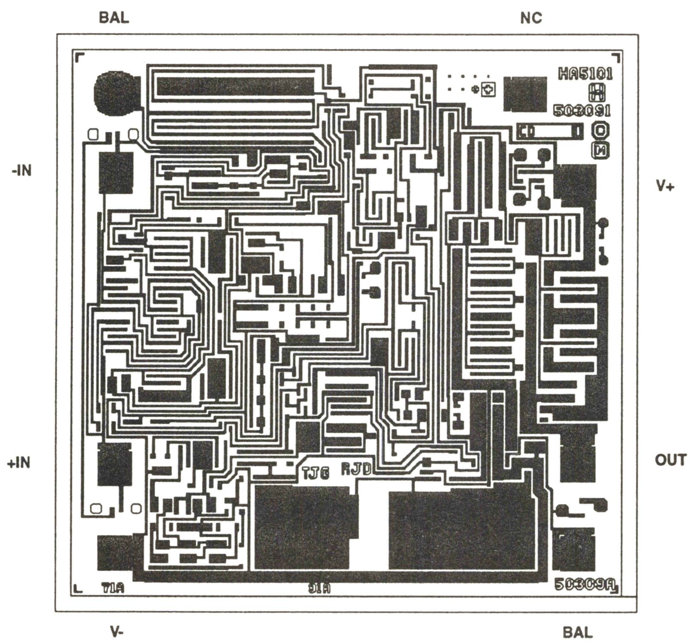
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 54

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5101/883



## Die Characteristics

**DIE DIMENSIONS:**
70 x 70 x 19 mils ± 1 mils
1790 x 1780 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.38 \times 10^5 A/cm^2$

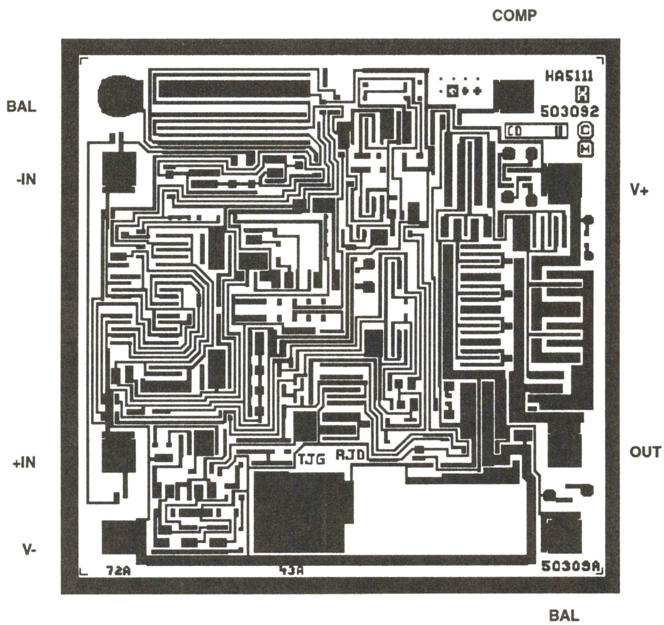
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 54

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5111/883



## Die Characteristics

**DIE DIMENSIONS:**
97 x 103 x 19 mils ± 1 mils
2460 x 2610 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$0.45 \times 10^5 A/cm^2$

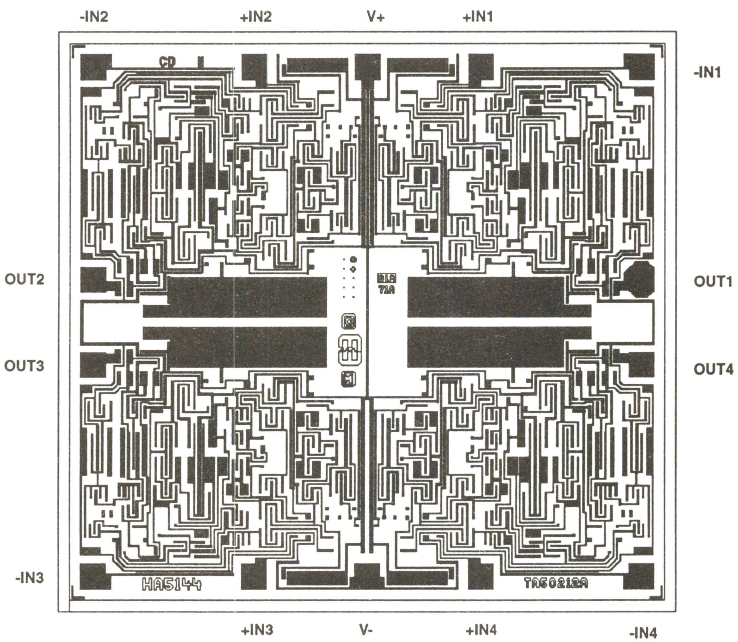
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 144

**PROCESS:** Bipolar/JFET Dielectric Isolation

## Metallization Mask Layout

HA-5144/883



## Die Characteristics

**DIE DIMENSIONS:**
54 x 88 x 19 mils ± 1 mils
1360 x 2240 x 483µm ± 25.4µm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride ($Si_3N_4$) over Silox ($SiO_2$, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.29 \times 10^5 A/cm^2$

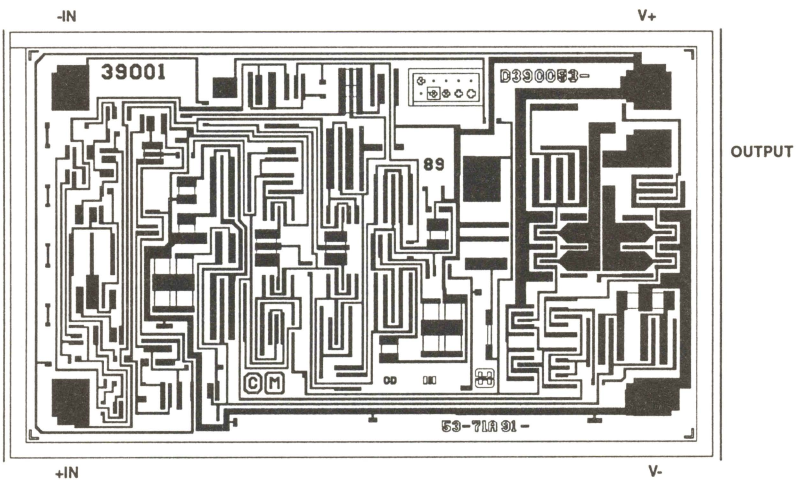
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 49

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5190/883



## Die Characteristics

**DIE DIMENSIONS:**
99 x 166 x 19 mils ± 1 mils
2510 x 4210 x 483μm ± 25.4μm

**METALLIZATION:**
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**
Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**
$1.36 \times 10^5 A/cm^2$

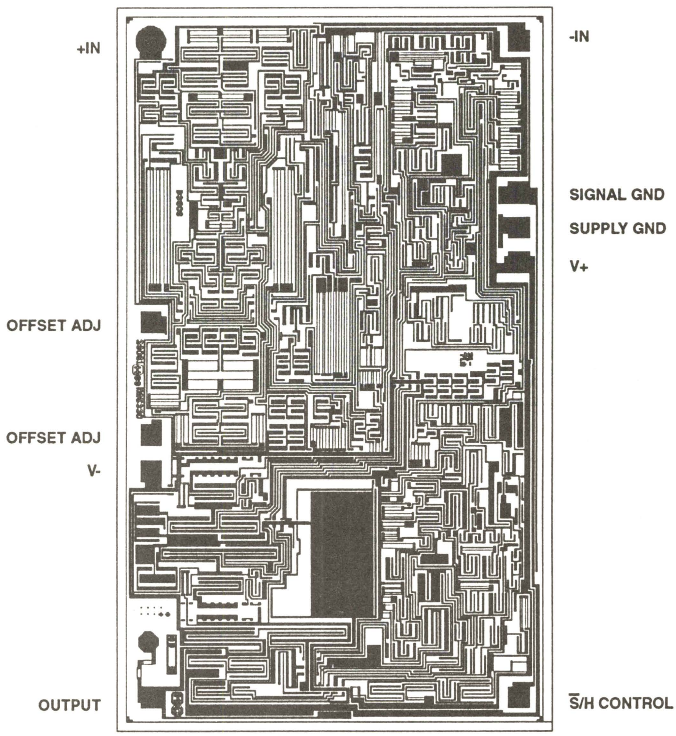
**SUBSTRATE POTENTIAL (Powered Up):** Signal GND

**TRANSISTOR COUNT:** 205

**PROCESS:** Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-5330/883



# ANALOG 10

## QUALITY AND RELIABILITY

# Harris Quality

## Introduction

Success in the integrated circuit industry means more than simply meeting or exceeding the demands of today's market. It also includes anticipating and accepting the challenges of the future. It results from a process of continuing improvement and evolution, with perfection as the constant goal.

Harris Semiconductor's commitment to supply only top value integrated circuits has made quality improvement a mandate for every person in our work force – from circuit designer to manufacturing operator, from hourly employee to corporate executive. Price is no longer the only determinant in marketplace competition. Quality, reliability, and performance enjoy significantly increased importance as measures of value in integrated circuits.

Quality in integrated circuits cannot be added or considered after the fact. It begins with the development of capable process technology and product design. It continues in manufacturing, through effective controls at each process or step. It culminates in the delivery of products which meet or exceed the expectations of the customer.

## The Role of the Quality Organization

The emphasis on building quality into the design and manufacturing processes of a product has resulted in a significant refocus of the role of the Quality organization. In addition to facilitating the development of SPC and DOX, Quality professionals support other continuous improvement tools such as control charts, measurement of equipment capability, standardization of inspection equipment and processes, procedures for chemical controls, analysis of inspection data and feedback to the manufacturing areas, coordination of efforts for process and product improvement, optimization of environmental or raw materials quality, and the development of quality improvement programs with vendors.

At critical manufacturing operations, process and product quality is analyzed through random statistical sampling and product monitors. The Quality organization's role is changing from policing quality to leadership and coordination of quality programs or procedures through auditing, sampling, consulting, and managing Quality Improvement projects.

To support specific market requirements, or to ensure conformance to military or customer specifications, the Quality organization still performs many of the conventional quality functions (e.g., group testing for military products or wafer lot acceptance). But, true to the philosophy that quality is everyone's job, much of the traditional on-line measurement and control of quality characteristics is where it belongs – with the people who make the product. The Quality organization is there to provide leadership and assistance in the deployment of quality techniques, and to monitor progress.

## The Improvement Process

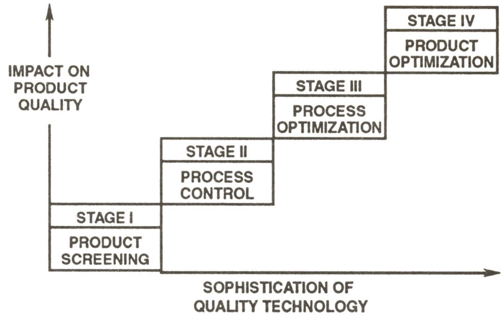



**FIGURE 1. STAGES OF STATISTICAL QUALITY TECHNOLOGY**

Harris Semiconductor's quality methodology is evolving through the stages shown in Figure 1. In 1981 we embarked on a program to move beyond Stage I, and we are currently in the transition from Stage III to Stage IV, as more and more of our people become involved in quality activities. The traditional "quality" tasks of screening, inspection, and testing are being replaced by more effective and efficient methods, putting new tools into the hands of all employees. Table 1 illustrates how our quality systems are changing to meet today's needs.

## Designing for Manufacturability

Assuring quality and reliability in integrated circuits begins with good product and process design. This has always been a strength in Harris Semiconductor's quality approach. We have a very long lineage of high reliability, high performance products that have resulted from our commitment to design excellence. All Harris products are designed to meet the stringent quality and reliability requirements of the most demanding end equipment applications, from military and space to industrial and telecommunications. The application of new tools and methods has allowed us to continuously upgrade the design process.

Each new design is evaluated throughout the development cycle to validate the capability of the new product to meet the end market performance, quality, and reliability objectives.

The validation process has four major components:

1. Design simulation/optimization
2. Layout verification
3. Product demonstration
4. Reliability assessment

TABLE 1. TYPICAL ON-LINE MANUFACTURING/QUALITY FUNCTIONS

| AREA | FUNCTION | MANUFACTURING CONTROLS | QA/QC MONITOR AUDIT |
|---|---|---|---|
| Wafer Fab | • QML/JAN Self-Audit | | X |
| | • Environmental | | |
| | - Room/Hood Particulates | X | X |
| | - Temperature/Humidity | X | X |
| | - Water Quality | | X |
| | • Product | | |
| | - Junction Depth | X | |
| | - Sheet Resistivities | X | |
| | - Defect Density | X | X |
| | - Critical Dimensions | X | X |
| | - Visual Inspection | X | X |
| | - Lot Acceptance | X | |
| | • Process | | |
| | - Film Thickness | X | X |
| | - Implant Dosages | X | |
| | - Capacitance Voltage Changes | X | X |
| | - Conformance to Specification | X | X |
| | • Equipment | | |
| | - Repeatability | X | X |
| | - Profiles | X | X |
| | - Calibration | | X |
| | - Preventive Maintenance | X | X |
| Assembly | • QML/JAN Self-Audit | | X |
| | • Environmental | | |
| | - Room/Hood Particulates | X | X |
| | - Temperature/Humidity | X | X |
| | - Water Quality | | X |
| | • Product | | |
| | - Documentation Check | | X |
| | - Dice Inspection | X | X |
| | - Wire Bond Pull Strength/Controls | X | X |
| | - Ball Bond Shear/Controls | | X |
| | - Die Shear Controls | | X |
| | - Post-Bond/Pre-Seal Visual | X | X |
| | - Fine/Gross Leak | X | X |
| | - PIND Test | X | |
| | - Lead Finish Visuals, Thickness | X | X |
| | - Solderability | X | X |
| | • Process | | |
| | - Operator Quality Performance | X | X |
| | - Saw Controls | X | |
| | - Die Attach Temperatures | X | X |
| | - Seal Parameters | X | |
| | - Seal Temperature Profile | X | X |
| | - Sta-Bake Profile | X | |
| | - Temp Cycle Chamber Temperature | X | X |
| | - ESD Protection | X | X |
| | - Plating Bath Controls | X | X |
| | - Mold Parameters | X | X |

TABLE 1. TYPICAL ON-LINE MANUFACTURING/QUALITY FUNCTIONS (Continued)

| AREA | FUNCTION | MANUFACTURING CONTROLS | QA/QC MONITOR AUDIT |
|---|---|---|---|
| Test | • QML/JAN Self-Audit | | X |
| | • Temperature/Humidity | X | X |
| | • ESD Controls | X | X |
| | • Temperature Test Calibration | X | |
| | • Test System Calibration | X | |
| | • Test Procedures | | X |
| | • Control Unit Compliance | X | X |
| | • Lot Acceptance Conformance | X | X |
| | • Group A Lot Acceptance | | X |
| Probe | • QML/JAN Self-Audit | | X |
| | • Wafer Repeat Correlation | X | |
| | • Visual Requirements | X | X |
| | • Documentation | X | X |
| | • Process Performance | X | X |
| Burn-In | • QML/JAN Self-Audit | | X |
| | • Functionality Board Check | X | |
| | • Oven Temperature Controls | X | |
| | • Procedural Conformance | | X |
| Brand | • QML/JAN Self-Audit | | X |
| | • ESD Controls | X | X |
| | • Brand Permanency | X | X |
| | • Temperature/Humidity | X | |
| | • Procedural Conformance | | X |
| QCI Inspection | • QML/JAN Self-Audit | | X |
| | • Group B Conformance | | X |
| | • Group C and D Conformance | | X |

## Quality Systems

### Qualified Manufacturers List (QML)

Harris Semiconductor has been a certified supplier of JAN products since the early 1970's. In August, 1993, Harris began a transition phase for the JAN and MIL-STD-883 compliant product portfolio to QML in conformance with the requirements of MIL-I-38535. The QML program utilizes a "best commercial practices" philosophy to manufacture integrated circuits for all classes of military products. This QML philosophy ties directly into existing Harris systems and programs such as statistical process control of critical processes and utilization of continuous improvement teams to continually raise product quality, reliability, manufacturability, and performance. The transition to this culture eliminates the need for much of the present end-of-line testing which was defined in a period when Quality was inspected into the product rather than manufactured into the product.

QML manufacturing lines will, in the near future, eliminate much of the end-of-line testing through demonstration of product quality through process control. In turn, much of the present paperwork in the form of attributes and other records demonstrating "inspection of quality into the product" will no longer be provided. By following this charter, the burden of quality and reliability is placed in the manufacturing arena which is where the solutions reside.

### ISO-9000

Harris Semiconductor's wafer fabrication and I.C. assembly and test operations have received ISO-9002 certification. The certification for this international standard was achieved with minimal effort based on the years of performance in the military market coupled with the implementation of a Total Quality Management system. Harris TQM system and ISO compliance, combined, provide a synergetic quality system which supports the Harris corporate quality policy.

## Special Testing

Harris Semiconductor offers several standard screen flows to support a customer's need for additional testing and reliability assurance. These flows include environmental stress testing, burn-in, and electrical testing at temperatures other than +25$^{o}$C. The flow shown in Figure 2 indicates the Harris standard processing flow for a Compliant Military Device. In addition, Harris can supply products tested to customer specifications both for electrical requirements and for non-standard environmental stress screening. Consult your field sales representative for details.

## Harris Semiconductor Standard Processing Flow

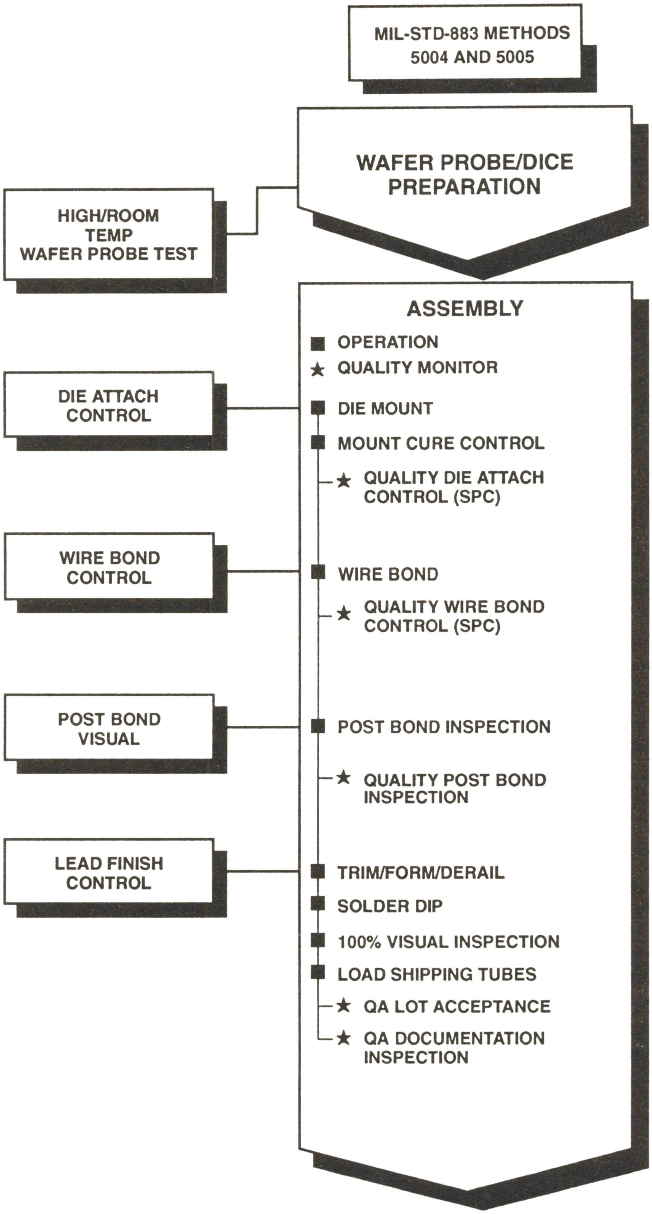



FIGURE 2A.

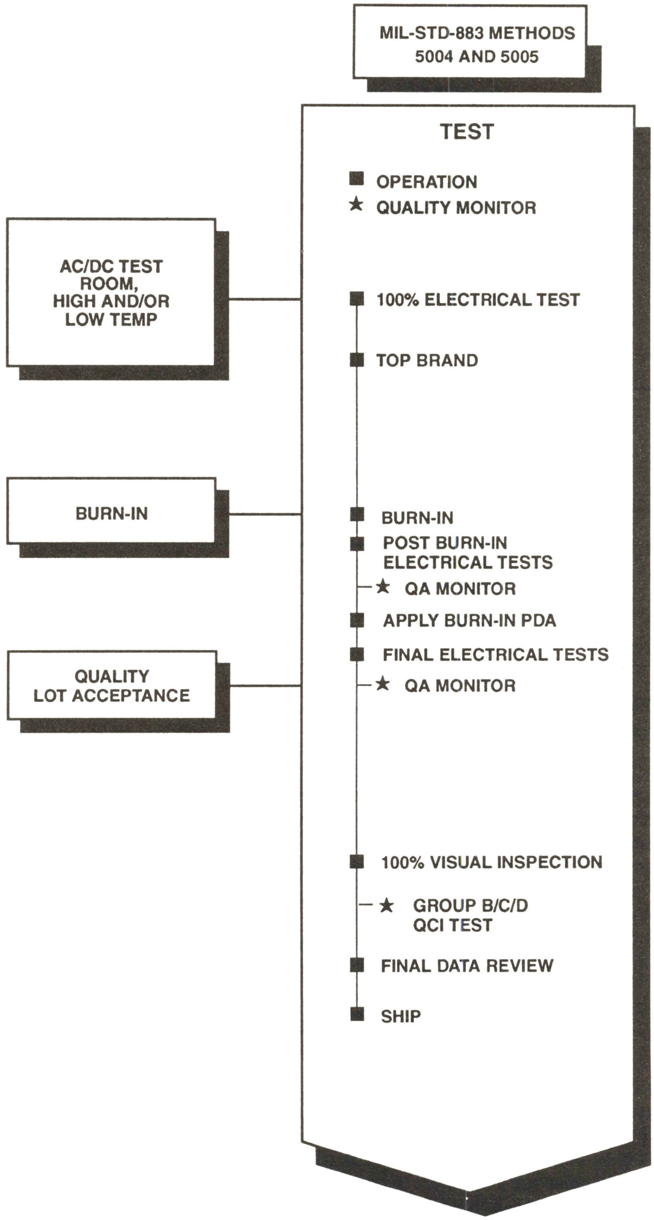

MIL-STD-883 METHODS 5004 AND 5005
TEST
■ OPERATION
★ QUALITY MONITOR
AC/DC TEST ROOM, HIGH AND/OR LOW TEMP
100% ELECTRICAL TEST
TOP BRAND
BURN-IN
BURN-IN
POST BURN-IN ELECTRICAL TESTS
QA MONITOR
APPLY BURN-IN PDA
QUALITY LOT ACCEPTANCE
FINAL ELECTRICAL TESTS
QA MONITOR
100% VISUAL INSPECTION
GROUP B/C/D QCI TEST
FINAL DATA REVIEW
SHIP

FIGURE 2B.

TABLE 2. PROCESS CONTROL APPLICATIONS

| FAB | | |
|---|---|---|
| • Diffusion<br>- Junction Depth<br>- Sheet Resistivities<br>- Oxide Thickness | • Thin Film<br>- Film Thickness<br>- Refractive Index<br>- Film Composition<br>- Metal Step Coverage | • Photo Resist<br>- Critical Dimension<br>- Resist Thickness<br>- Etch Rates |
| **ASSEMBLY** | | |
| • Pre-Seal<br>- Die Prep Visuals<br>- Die Attach Heater Block<br>- Die Shear<br>- Wire Pull<br>- Ball Bond Shear<br>- Saw Blade Wear<br>- Pre-Cap Visuals | • Post-Seal<br>- Internal Package Moisture<br>- PIND Defect Rate<br>- Solder Thickness<br>- Package Hermeticity Tests<br>- Lid Torque<br>- Temperature Cycle | |
| **TEST** | | |
| | - Handlers/Test System<br>- Defect Pareto Charts<br>- Lot % Defective<br>- ESD Failures per Month<br>- After Burn-In PDA | |
| **OTHER** | | |
| • Receiving Inspection<br>- Vendor Performance<br>- Material Criteria<br>- Quality Levels<br>- Plated Finish Thickness | • Environment<br>- Water Quality<br>- Clean Room Control<br>- Temperature<br>- Humidity | |

## Controlling and Improving the Manufacturing Process - SPC/DOX

Statistical process control (SPC) is the basis for quality control and improvement at Harris Semiconductor. Harris manufacturing people use control charts to determine the normal variabilities in processes, materials, and products. Critical process variables and performance characteristics are measured and control limits are plotted on the control charts. Appropriate action is taken if the charts show that an operation is outside the process control limits or indicates a nonrandom pattern inside the limits. These same control charts are powerful tools for use in reducing variations in processing, materials, and products. Table 2 lists some typical manufacturing applications of control charts at Harris Semiconductor.

SPC is important, but still considered only part of the solution. Processes which operate in statistical control are not always capable of meeting engineering requirements. The conventional way of dealing with this in the semiconductor industry has been to implement 100% screening or inspection steps to remove defects, but these techniques are insufficient to meet today's demands for the highest reliability and perfect quality performance.

Harris still uses screening and inspection to "grade" products and to satisfy specific customer requirements for burn-in, multiple temperature test insertions, environmental screening, and visual inspection as value-added testing options. However, inspection and screening are limited in their ability to reduce product defects to the levels expected by today's buyers. In addition, screening and inspection have an associated expense, which raises product cost (see Table 3).

TABLE 3. APPROACH AND IMPACT OF STATISTICAL QUALITY TECHNOLOGY

| STAGE | | APPROACH | IMPACT |
|---|---|---|---|
| I | Product Screening | • Stress and Test<br>• Defective Prediction | • Limited Quality<br>• Costly<br>• After-The-Fact |
| II | Process Control | • Statistical Process Control<br>• Just-In-Time Manufacturing | • Identifies Variability<br>• Reduces Costs<br>• Real Time |
| III | Process Optimization | • Design of Experiments<br>• Process Simulation | • Minimizes Variability<br>• Before-The-Fact |
| IV | Product Optimization | • Design for Producibility<br>• Product Simulation | • Insensitive to Variability<br>• Designed-In Quality<br>• Optimal Results |

Harris engineers are, instead, using Design of Experiments (DOX), a scientifically disciplined mechanism for evaluating and implementing improvements in product processes, materials, equipment, and facilities. These improvements are aimed at reducing the number of defects by studying the key variables controlling the process, and optimizing the procedures or design to yield the best result. This approach is a more time-consuming method of achieving quality perfection, but a better product results from the efforts, and the basic causes of product nonconformance can be eliminated.

SPC, DOX, and design for manufacturability, coupled with our 100% test flows, combine in a product assurance program that delivers the quality and reliability performance demanded for today and for the future.

## Average Outgoing Quality (AOQ)

Average Outgoing Quality is a yardstick for our success in quality manufacturing. The average outgoing electrical defective is determined by randomly sampling units from each lot and is measured in parts per million (PPM). The current procedures and sampling plans outlined in MIL-STD-883 and MIL-I-38535 are used by our quality inspectors.

The focus on this quality parameter has resulted in a continuous improvement to less than 100 PPM, and the goal is to continue improvement toward 0 PPM.

## Training

The basis of a successful transition from conventional quality programs to more effective, total involvement is training. Extensive training of personnel involved in product manufacturing began in 1984 at Harris, with a comprehensive development program in statistical methods. Using the resources of Harris statisticians, private consultants, and internally developed programs, training of engineers, supervisors, and operators/technicians has been an ongoing activity in Harris Semiconductor.

Over the past years, Harris has also deployed a comprehensive training program for hourly operators and supervisors in job requirements and functional skills. All hourly manufacturing employees participate (see Table 4).

## Incoming Materials

Improving the quality and reducing the variability of critical incoming materials is essential to product quality enhancement, yield improvement, and cost control. With the use of statistical techniques, the influence of silicon, chemicals, gases and other materials on manufacturing is highly measurable. Current measurements indicate that results are best achieved when materials feeding a statistically controlled manufacturing line have also been produced by statistically controlled vendor processes.

To assure optimum quality of all incoming materials, Harris has initiated an aggressive program, linking key suppliers with our manufacturing lines. This user-supplier network is the Harris Vendor Certification process by which strategic vendors, who have performance histories of the highest quality, participate with Harris in a lined network; the vendor's factory acts as if it were a beginning of the Harris production line.

SPC seminars, development of open working relationships, understanding of Harris's manufacturing needs and vendor capabilities, and continual improvement programs are all part of the certification process. The sole use of engineering limits no longer is the only quantitative requirement of incoming materials.

**TABLE 4. SUMMARY OF TRAINING PROGRAMS**

| COURSE | AUDIENCE | TOPICS COVERED |
|---|---|---|
| SPC, Basic | Manufacturing Operators, Non-Manufacturing Personnel | Harris Philosophy of SPC, Statistical Definitions, Statistical Calculations, Problem Analysis Tools, Graphing Techniques, Control Charts |
| SPC, Intermediate | Manufacturing Supervisors, Technicians | Harris Philosophy of SPC, Statistical Definitions, Statistical Calculations, Problem Analysis Tools, Graphing Techniques, Control Charts, Distributions, Measurement Process Evaluation, Introduction to Capability |
| SPC, Advanced | Manufacturing Engineers, Manufacturing Managers | Harris Philosophy of SPC, Statistical Definitions, Statistical Calculations, Problem Analysis Tools, Graphing Techniques, Control Charts, Distributions, Measurement Process Evaluation, Advanced Control Charts, Variance Component Analysis, Capability Analysis |
| Design of Experiments (DOX) | Engineers, Managers | Factorial and Fractional Designs, Blocking Designs, Nested Models, Analysis of Variance, Normal Probability Plots, Statistical Intervals, Variance Component Analysis, Multiple Comparison Procedures, Hypothesis Testing, Model Assumptions/Diagnostics |
| Regression | Engineers, Managers | Simple Linear Regression, Multiple Regression, Coefficient Interval Estimation, Diagnostic Tools, Variable Selection Techniques |
| Response Surface Methods (RSM) | Engineers, Managers | Steepest Ascent Methods, Second Order Models, Central Composite Designs, Contour Plots, Box-Behnken Designs |

Specified requirements include centered means, statistical control limits, and the requirement that vendors deliver their products from their own statistically evaluated, in-control manufacturing processes.

In addition to the certification process, Harris has worked to promote improved quality in the performance of all our qualified vendors who must meet rigorous incoming inspection criteria (see Table 5).

**TABLE 5. INCOMING QUALITY CONTROL MATERIAL QUALITY CONFORMANCE**

| MATERIAL | INCOMING INSPECTIONS | VENDOR DATA REQUIREMENTS |
|---|---|---|
| Silicon | • Resistivity<br>• Crystal Orientation<br>• Dimensions<br>• Edge Conditions<br>• Taper<br>• Thickness<br>• Total Thickness Variation<br>• Backside Criteria<br>• Oxygen<br>• Carbon | • Equipment Capability Control Charts<br>- Oxygen<br>- Resistivity<br>• Control Charts Related to<br>- Enhanced Gettering<br>- Total Thickness Variation<br>- Total Indicated Reading<br>- Particulates<br>• Certificate of Analysis for all Critical Parameters<br>• Control Charts from On-Line Processing<br>• Certificate of Conformance |
| Chemicals/Photoresists/ Gases | • Chemicals<br>- Assay<br>- Major Contaminants<br>• Molding Compounds<br>- Spiral Flow<br>- Thermal Characteristics<br>• Gases<br>- Impurities<br>• Photoresists<br>- Viscosity<br>- Film Thickness<br>- Solids | • Certificate of Analysis on all Critical Parameters<br>• Certificate of Conformance<br>• Control Charts from On-Line Processing<br>• Control Charts<br>- Assay<br>- Contaminants<br>- Water<br>- Selected Parameters<br>• Control Charts<br>- Assay<br>- Contaminants<br>• Control Charts on<br>- Photospeed<br>- Thickness<br>- UV Absorbance<br>- Filterability<br>- Water<br>- Contaminants |
| Thin Film Materials | • Assay<br>• Selected Contaminants | • Control Charts from On-Line Processing<br>• Control Charts<br>- Assay<br>- Contaminants<br>- Dimensional Characteristics<br>• Certificate of Analysis for all Critical Parameters<br>• Certificate of Conformance |
| Assembly Materials | • Visual Inspection<br>• Physical Dimension Checks<br>• Glass Composition<br>• Bondability<br>• Intermetallic Layer Adhesion<br>• Ionic Contaminants<br>• Thermal Characteristics<br>• Lead Coplanarity<br>• Plating Thickness<br>• Hermeticity | • Certificate of Analysis<br>• Certificate of Conformance<br>• Process Control Charts on Outgoing Product Checks and In-Line Process Controls |

## Calibration Laboratory

Another important resource in the product assurance system is a calibration lab in each Harris Semiconductor operation site. These labs are responsible for calibrating the electronic, electrical, electro/mechanical, and optical equipment used in both production and engineering areas. The accuracy of instruments used at Harris is traceable to a national standards. Each lab maintains a system which conforms to the current revision of MIL-STD-45662A, "Calibration System Requirements."

Each instrument requiring calibration is assigned a calibration interval based upon stability, purpose, and degree of use. The equipment is labeled with an identification tag on which is specified both the date of the last calibration and of the next required calibration. The Calibration Lab reports on a regular basis to each user department. Equipment out of calibration is taken out of service until calibration is performed. The Quality organization performs periodic audits to assure proper control in the using areas. Statistical procedures are used where applicable in the calibration process.

## Manufacturing Science - CAM, JIT, TPM

In addition to SPC and DOX as key tools to control the product and processes, Harris is deploying other management mechanisms in the factory. On first examination, these tools appear to be directed more at schedules and capacity. However, they have a significant impact on quality results.

**Computer Aided Manufacturing (CAM)**

CAM is a computer based inventory and productivity management tool which allows personnel to quickly identify production line problems and take corrective action. In addition, CAM improves scheduling and allows Harris to more quickly respond to changing customer requirements and aids in managing work in process (WIP) and inventories.

The use of CAM has resulted in significant improvements in many areas. Better wafer lot tracking has facilitated a number of process improvements by correlating yields to process variables. In several places CAM has greatly improved capacity utilization through better planning and scheduling. Queues have been reduced and cycle times have been shortened - in some cases by as much as a factor of 2.

The most dramatic benefit has been the reduction of WIP inventory levels, in one area by 500%. This results in fewer lots in the area and a resulting quality improvement. In wafer fab, defect rates are lower because wafers spend less time in production areas awaiting processing. Lower inventory also improves morale and brings a more orderly flow to the area. CAM facilitates all of these advantages.

**Just In Time (JIT)**

The major focus of JIT is cycle time reduction and linear production. Significant improvements in these areas result in large benefits to the customer. JIT is a part of the Total Quality Management philosophy at Harris and includes Employee Involvement, Total Quality Control, and the total elimination of waste.

Some key JIT methods used for improvement are sequence of events analysis for the elimination of non-value added activities, demand/pull to improve production flow, TQC check points and Employee Involvement Teams using root cause analysis for problem solving.

JIT implementations at Harris Semiconductor have resulted in significant improvements in cycle time and linearity. The benefits from these improvements are better on time delivery, improved yield, and a more cost effective operation.

JIT, SPC, and TPM are complementary methodologies and used in conjunction with each other create a very powerful force for manufacturing improvement.

**Total Productive Maintenance (TPM)**

TPM or Total Productive Maintenance is a specific methodology which utilizes a definite set of principles and tools focusing on the improvement of equipment utilization. It focuses on the total elimination of the six major losses which are equipment failures, setup and adjustment, idling and minor stoppages, reduced speed, process defects, and reduced yield. A key measure of progress within TPM is the overall equipment effectiveness which indicates what percentage of the time is a particular equipment producing good parts. The basic TPM principles focus on maximum equipment utilization, autonomous maintenance, cross functional team involvement, and zero defects. There are some key tools within the TPM technical set which have proven to be very powerful to solve long standing problems. They are initial clean, P-M analysis, condition based maintenance, and quality maintenance.

Utilization of TPM has shown significant increases in utilization on many tools across the Sector and is rapidly becoming widespread and recognized as a very valuable tool to improve manufacturing competitiveness.

The major benefits of TPM are capital avoidance, reduced costs, increased capability, and increased quality. It is also very compatible with SPC techniques since SPC is a good stepping stone to TPM implementation and it is in turn a good stepping stone to JIT because a high overall equipment effectiveness guarantees the equipment to be available and operational at the right time as demanded by JIT.

# Harris Reliability

## Introduction

At Harris Semiconductor, reliability is built into every product by emphasizing quality throughout manufacturing. This starts by ensuring the excellence of the design, layout, and manufacturing processes. The quality of the raw materials and workmanship is monitored using statistical process control (SPC) to preserve the reliability of the product. The primary and ultimate goal of these efforts is to provide full performance to the product specification throughout its useful life.

## Reliability Engineering

The Reliability Engineering department is responsible for all aspects of reliability assurance at Harris Semiconductor:

- Charter
  - To ensure that Harris is recognized by our customers and competitors as a company that consistently delivers products with high reliability.

- Mission
  - To develop systems for assessing, enhancing, and assuring that quality and reliability are integrated into all aspects of our business.

- Vision
  - To establish excellence and integrity through all design and manufacturing processes as it relates to quality and reliability.

Values

- To be considered responsive and service oriented by our customers.
- To be acknowledged by Harris as a highly qualified resource for reliability assurance, product analysis, and electronic materials characterization.
- To successfully utilize the organization's talents through trained, empowered employees/employee team participation.
- To maintain an attitude of integrity, dignity and respect for all.

Strategy

- To provide quantitative assessments of product reliability focusing on the identification and timely elimination of design and processing deficiencies that degrade product performance and operating life expectancy.
- To provide systems for continuous improvement of reliability and quality through the assessment of existing processes, products, and packages.
- To perform product analysis as a means of problem solving and feedback to our customers, both internal and external.
- To exercise full authority over the internal qualifications of new products, processes, and packages.

The reliability organization is comprised of a team that possesses a broad cross section of expertise in these areas:

- Custom Military (Radiation Hardened)
- Automotive ASICs
- Harsh Environment Plastic Packaging
- Advanced Methods for Design for Reliability (DFR)
- Strength in Power Semiconductor
- Chemical/Surface Analysis Capabilities
- Failure Analysis Capabilities

The reliability focus is customer satisfaction (external and internal) and is accomplished through the development of standards, performance metrics, and service systems. These major systems are summarized below:

- A process and product development system known as ACT PTM (Applying Concurrent Teams to Product-To-Market) has been established. The ACT PTM philosophy is one of new product development through a team that pursues customer involvement. The team has the authority, responsibility, and training necessary to successfully bring the product to market. This not only includes product definition and design, but also all manufacturing capabilities as well.
- Standard test vehicles (over 100) have been developed for process characterization of wear-out failure mechanisms. These vehicles are used for conventional stresses (for modeling failure rates) and for wafer level reliability characterization during development.
- Common qualification standards have been established for all sites.
- A reliability monitoring system (also known as the Matrix monitoring system) is utilized for products in production to ensure ongoing reliability and verification of continuous improvement.
- The field return system is designed to handle a variety of customer issues in a timely manner. Product issues are often handled by routing the product into the PFAST (Product Failure Analysis Solution Team) system. Return authorizations (RAs) are issued where an entire lot of product needs to be returned to Harris. The Customer Return Services (CRS) group is responsible for the administration of this system (see Customer Return Services.)
- The PFAST system has been established to expedite failure analysis, failure root cause determination, and corrective actions for field returns. PFAST is a team effort involving many functional areas at all Harris sites. The purpose of this system is to enable Harris's Field Sales and Quality operations to properly route, track, and respond to our customer's needs as they relate to product analysis.

## Design for Reliability (Wear-Out Characterization)

The concept of "Design for Reliability" focuses on moving reliability assessment away from tests on sample product to a point much earlier in the design cycle. Effort is directed at building in and verifying the reliability of a new process well

before manufacture of the first shippable product that uses that technology. This gives these first new products a higher probability of success and achieves reduced product-to-market cycle times.

In practice, a set of standardized test vehicles containing special test structures are transferred to the new process using the layout ground rules specified for that process. Each test structure is designed for a specific wear-out failure mechanism. Highly accelerated stress tests are performed on these structures and the results can be extrapolated to customer use conditions. Generally, log-normal statistics are used to define wear-out distributions for the life prediction models. The results are used to establish reliability design ground rules and critical node lists for each process. These ground rules and critical nodes ensure that wear-out failures do not occur during the customer's projected use of the product.

## Process/Product/Package Qualifications

Once the new process has successfully completed wear-out characterization, the final qualification consists of more conventional testing (e.g. biased life, storage life, temp cycle etc.). These tests are performed on the first new product designs (sampled across multiple wafer production lots). Successful completion of the final qualification tests concurrently qualifies the new process and the new products that were used in the qualification. Subsequent products designed within the now-established ground rules are qualified individually prior to introduction. New package configurations are also qualified individually prior to being available for use with new products.

Harris's qualification procedures are specified via controlled documentation and the same standard is used at Harris's sites worldwide. Figure 4 gives more information on the new process/product development and life cycle.

## Product/Package Reliability Monitors

Many of the accelerated stress-tests used during initial reliability qualification are also employed during the routine monitoring of standard product. Harris's continuing reliability monitoring program consists of three groups of stress tests, labeled Matrix I, II and III. Table 6 outlines the Matrix tests used to monitor plastic packaged ICs in Harris's off-shore assembly plants, where each wafer fab technology is sampled. Matrix I consists of highly accelerated, short duration (typically 48 hours) tests, sampled biweekly, which provide real-time feedback on product reliability. Matrix II consists of the more conventional, longer term stress-tests, sampled monthly, which are similar to those used for product qualification. Finally, Matrix III, performed monthly on each package style, monitors the mechanical reliability aspects of the package. Any failures occurring on the Matrix monitors are fully analyzed and the failure mechanisms identified, with containment and corrective actions obtained from Manufacturing and Engineering. This information along with all of the test results are routinely transmitted to a central data base in Reliability Engineering, where failure rate trends are analyzed and tracked on an ongoing basis. These data are used to drive product improvements, to ensure that failure rates are continuously being reduced over time.

Reliability data, including the Matrix Monitor results, can be obtained by contacting your local Harris sales office.

**TABLE 6. PLASTIC PACKAGED IC MONITORING TESTS**

**MATRIX I**

| TEST | CONDITIONS | DURATION | SAMPLE/ LTPD |
|---|---|---|---|
| Autoclave | +121°C, 100%RH, 15PSIG | 96 Hours | 45/5 |
| Biased Life | +175°C | 48 Hours | 45/5 |
| Biased Life | +125°C | 48 Hours | 45/5 |
| HAST | +135°C, 85% RH | 48 Hours | 45/5 |
| Thermal Shock | -65°C to +150°C | 200 Cycles | 45/5 |

**MATRIX II**

| TEST | CONDITIONS | DURATION | SAMPLE/ LTPD |
|---|---|---|---|
| Autoclave | +121°C, 100%RH, 15PSIG | 192 Hours | 45/5 |
| Biased Humidity | +85°C, 85% RH | 1000 Hours | 45/5 |
| Biased Life | +125°C | 1000 Hours | 45/5 |
| Dynamic Life | +125°C | 1000 Hours | 45/5 |
| Storage Life | +150°C | 1000 Hours | 45/5 |
| Temp. Cycle | -65°C to +150°C | 1000 Cycles | 45/5 |

**MATRIX III**

| TEST | CONDITIONS | SAMPLE/LTPD |
|---|---|---|
| Brand Adhesion | MIL-STD-883/2015 | 15/15 |
| Flammability | (UL-94 Vertical Burn) | 11/20 |
| Lead Fatigue | MIL-STD-883/2004 | 15/15 |
| Physical Dimensions | MIL-STD-883/2016 | 11/20 |
| Solderability | MIL-STD-883/2003 | 45/15 |

| FLOW - PROCESS/PRODUCT DEVELOPMENT | RELIABILITY FOCUS |
|---|---|
| PRODUCT DEFINITION REVIEW | • Assumes process development required |
| CONCEPT REVIEW | • Evaluate reliability risks factors<br>• Attain commitment for test vehicle development |
| DESIGN REVIEW | • Review test vehicle development and stress test plan<br>• Review package requirements and ESD requirements<br>• Review latent random failure mechanism history and design for elimination<br>• Review ground rules for design and elimination of wear-out mechanisms<br>• Review process characterization, statistical control and capability and critical node list<br>• Review device modeling and simulations<br>• Review process variability and producibility<br>• Define wafer level reliability vehicles |
| LAYOUT REVIEW | • Evaluate design of chip to package risk factors<br>• Review Design ground Rule Checks (DRCs)<br>• Establish reliability test, stress and failure analysis capabilities<br>• Project failure rate based on test vehicle data<br>• Review burn-in diagrams for production and qualification<br>• Review overall qualification plan |
| TEST VEHICLE FABRICATION | • Test vehicles and/or product constructed<br>• Conduct wear-out characterization and/or product stress testing |
| EVALUATION REVIEW | • Review test vehicle stress results<br>• Verify wear-out mechanisms are eliminated by design and Statistical Process Control (test vehicle + SPC)<br>• Review product characterization to data sheet, ESD, latch-up and Destructive Physical Analysis (DPA) results and define corrective actions<br>• Review of life test data and failure mechanisms. Define corrective actions<br>• Utilize statistical Design Of Experiments (DOX) if required to adjust process or design<br>• Define necessary changes to eliminate any systematic failure mechanism<br>• If mature process - grant generic release |
| NEW PRODUCT TRANSFER | • Qualification requirements complete and presented. Meet FIT rate requirements<br>• Review infant mortality burn-in results<br>• Initiate reliability monitor plan |
| MANUFACTURE | • Reliability Monitors:<br>- Matrix monitor assessment<br>- Military quality conformance testing<br>• Trend analysis of reliability performance used to develop product improvements<br>• Yield management support |
| SHIPMENT | • High quality and reliable products shipped to Harris customers |
| CONTINUOUS IMPROVEMENT | • Failure Analysis - Determine assignable cause of failure<br>• Closed loop corrective action process<br>• Continuous improvement objectives in product reliability and quality |

FIGURE 4. NEW PROCESS/PRODUCT DEVELOPMENT AND LIFE CYCLE

## *Customer Return Services*

Harris places a high priority on resolving customer return issues. The Customer Return Services (CRS) department is responsible for determining the best manner to handle a return issue as illustrated in Figure 5.

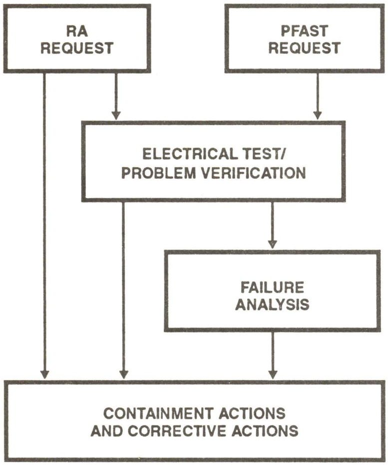



FIGURE 5. GENERAL RETURN FLOW

The diversity of return reasons requires that many different organizations be involved to test, analyze, and correct field return issues. The CRS group coordinates the responses from the supporting organizations to drive closure of issues within the customer response time requirements, see Table 7. The results from the work performed on customer returns are used to initiate corrective actions and continuous improvements within the factories. When the work on a return is completed, the customer is contacted to be certain all issues have been satisfactorily resolved.

The two methods used to return devices are by a RA (Return Authorization) request or by a PFAST (Product Failure Analysis Solution Team) request. The main difference between RA and PFAST is that the PFAST requests often require extensive analysis and a more formal response to the customer. All returns follow the same general procedure from the customer's perspective as seen in steps one to five of the customer return procedure.

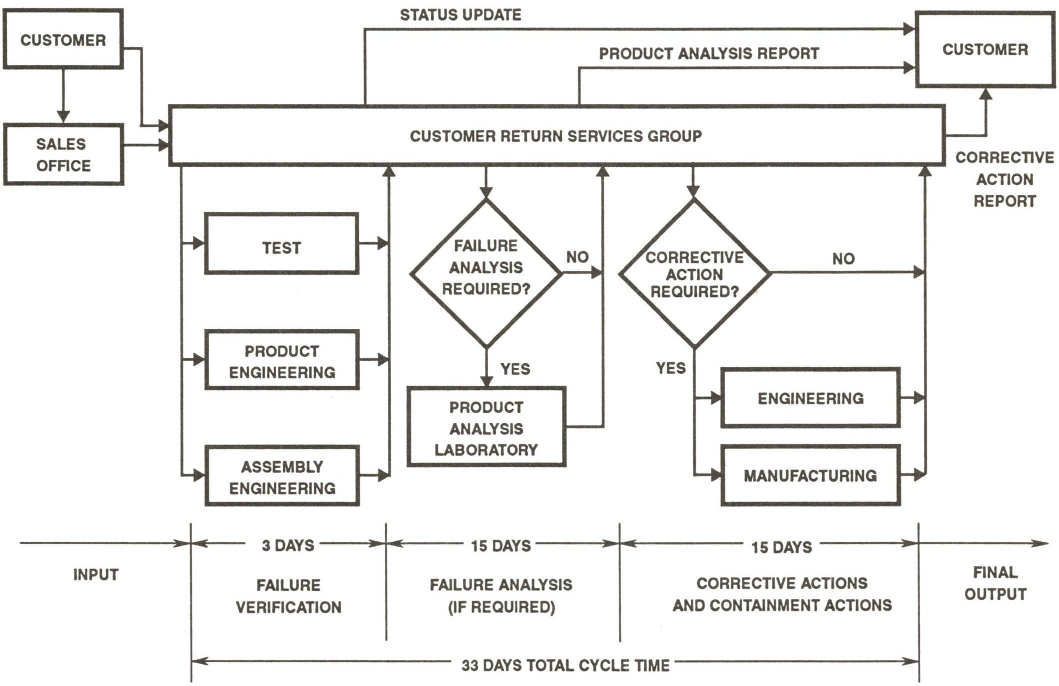
- **Step 1** - Customer or Sales office contacts the Customer Return Services department. If a return is to be routed into the PFAST system, then a PFAST Action Request (see the PFAST form in this section) needs to be completed to understand the customer's issue and direct the analysis efforts.
  - **Phone Number: (407)-724-7400**
  - **FAX Number: (407)-724-7658**
  - **Internet: creturn@huey.mis.semi.harris.com**
  - **PROFS: CRETURN**
- **Step 2** - The Customer Return Services department notifies all affected sales, factory, and engineering organizations of the issue.
- **Step 3** - When product is received, the issue is verified and any required analysis is performed. Where applicable, a preliminary analysis report is sent to the customer.
- **Step 4** - A determination of the root cause of failure initiates the corrective actions to address the source of the problem. A final corrective action report is sent to the customer if requested.
- **Step 5** - The Customer Return Services department contacts the customer to confirm that all issues have been handled properly and the customer is satisfied that the return is completed.

The RA request is used to return and replace an entire lot of product. The lot is returned to Harris for replacement or credit. Once the product is received various tests and evaluations will be performed to determine the appropriate actions that should be taken to resolve any problems or issues.

A PFAST request is used to return a small sample for analysis of a problem. The ultimate outcome of both types of requests is to determine corrective actions that would preclude the same problem occurring in the future. Where appropriate, a containment plan is also implemented to prevent a re-occurrence of the problem in the field. The customer return flow diagram (Figure 6) provides the typical activities and cycle times for processing a PFAST request.

TABLE 7. CUSTOMER RETURN SERVICES

| CHARTER | MISSION | RESPONSIBILITIES |
|---|---|---|
| To resolve product quality issues while providing feedback to both external and internal customers to facilitate corrective actions and continuous improvement of the product. | To provide a single point interface between the customer and the factory for resolving technical problems, issues, and field returns. | 1. Maintain customer return history.<br>2. Track returns through the factory.<br>3. Establish a history library of problems and corrective actions.<br>4. Ensure closure with customers. |




NOTE: The days indicated are the typical number of 'working days' not calendar days. Analysis difficulty and the nature of the corrective actions may either improve or degrade the total cycle time.

FIGURE 6. CUSTOMER RETURN FLOW DIAGRAM

HARRIS SEMICONDUCTOR

# PFAST ACTION REQUEST

**(Product Failure Analysis Solution Team)**

Request # ____________

Date: ____________

| | |
|---|---|
| Originator ____________ | Customer ____________ |
| Company/Phone No. ____________ | Location ____________ |
| Device Type/Part No. ____________ | Customer's Reference No. ____________ |
| No. Samples Returned ____________ | Quantity Received ____________ |

Instructions and requirements are on the back of this form.

Has Field Applications been contacted for assistance? ☐ No ☐ Yes - Who was contacted ____________

**SOURCE OF PROBLEM**
(Enter the sequence of events in the boxes provided)

1. Visual/Mechanical
   ☐ Describe ____________
2. Incoming Test ☐ Not Performed
   ☐ 100% Tested ☐ Sample Tested
   No. Tested ______ No. of Rejects ______
   Are results representative of previous lots?
   ☐ YES ☐ NO
3. In Process/Manufacturing Failure
   ☐ Board Test ☐ System Test
   How many units failed? ______
   Failed after ______hours of testing
   Was unit retested at incoming inspection?
   ☐ YES ☐ NO
   Are results representative of previous lots?
   ☐ YES ☐ NO
4. Field Failure
   Failed after ______hours operation
   Estimated failure rate______ % per ______
   End User____________ Location ____________
   Min. _____°C Ave. _____°C Max. _____°C
5. Other ____________

**ACTION REQUESTED BY CUSTOMER**

Specific Action Requested (Contact PFAST Coordinator for other options)

☐ Test Sample for Correlation Only
☐ Test Sample for Product Return >$5k
☐ Failure Analysis
☐ Other

Impact of Failed Units on Customer's Situation: ____________

Customer Contact with Specific Knowledge of Rejects
Name ____________
Position ____________ Phone____________

**REASON FOR ELECTRICAL REJECT**
(Where appropriate serialize units and specify for each)

Test Conditions Relating to Failure
Tester Used (Mfgr/Model) ____________
Test Temperature ____________
Test Time ☐ Continuous (T = _____sec)
☐ One Shot (T = _____sec)
Describe any observed condition to which failure appears sensitive ____________

1. ☐ DC Failure
   ☐ Open ☐ Short ☐ Leakage
   ☐ Power Drain ☐ Input Level ☐ Output Level
   Pin Number__________
2. ☐ AC Failure
   Power Supply Voltages = _____V
   Input Voltages $V_{IH}$ = _____V $V_{IL}$ = _____V
   Pin Number_______
   Failing characteristics ____________
3. ☐ RAM and ROM Failures (ROM failures must be returned with a good master unit if failure analysis is requested).
   Address of Failing Location ____________
   Describe Pattern Used (If not standard patterns, give very complete description including address sequence). ____________

Include timing diagrams and circuit schematic if available.
ROM Programmer Used (If purchased unprogrammed) ____________

Conformal Coating (Mfgr/Model) ____________

**Additional Comments:**

FIGURE 7. PFAST ACTION REQUEST

10
QUALITY AND RELIABILITY

## INSTRUCTIONS FOR COMPLETING PFAST ACTION REQUEST FORM

The purpose of this form is to help us provide you with a more accurate, complete, and timely response to failures which may occur. Accurate and complete information is essential to ensure that the appropriate corrective action can be implemented. Due to this need for accurate and complete information, requests without a completed PFAST Action Request form will be returned.

Source of Problem:

This section requests the product flow leading to the failure. Mark an 'X' in the appropriate boxes up to and including the step which detected the failure. Also mark an 'X' in the appropriate box under "ARE RESULTS REPRESENTATIVE OF PREVIOUS LOTS?" to indicate whether this is a rare failure or a repeated problem.

**Example 1.** No incoming electrical test was performed; the units were installed onto boards; the boards functioned correctly for two hours and then 1 unit failed. The customer rarely has a failure due to the Harris device.

**SOURCE OF PROBLEM**
(Enter the sequence of events in the boxes provided)

1. VISUAL/MECHANICAL
   ☐ DESCRIBE ______________________
2. INCOMING TEST ☒ NOT PERFORMED
   ☐ 100% TESTED ☐ SAMPLE TESTED
   NO. TESTED ______ NO. OF REJECTS ______
   ARE RESULTS REPRESENTATIVE OF PREVIOUS LOTS?
   ☐ YES ☐ NO
3. IN PROCESS/MANUFACTURING FAILURE
   ☒ BOARD TEST ☐ SYSTEM TEST
   HOW MANY UNITS FAILED? __1__
   FAILED AFTER __2__ HOURS OF TESTING
   WAS UNIT RETESTED AT INCOMING INSPECTION?
   ☐ YES ☒ NO
   ARE RESULTS REPRESENTATIVE OF PREVIOUS LOTS?
   ☐ YES ☒ NO
4. FIELD FAILURE
   FAILED AFTER ______ HOURS OPERATION
   ESTIMATED FAILURE RATE ______% PER ______
   END USER __________ LOCATION __________
   MIN. _____°C AVE. _____°C MAX. _____°C
5. OTHER ______________________

**Example 2.** 100 out of the 500 units shipped were tested at incoming and all passed. The units were installed into boards and the boards passed. The boards were installed into the system and the system failed immediately when turned on. There were 3 system failures due to this part. The customer frequently has failures of this Harris device. The 3 units were not retested at incoming.

**SOURCE OF PROBLEM**
(Enter the sequence of events in the boxes provided)

1. VISUAL/MECHANICAL
   ☐ DESCRIBE ______________________
2. INCOMING TEST ☐ NOT PERFORMED
   ☐ 100% TESTED ☒ SAMPLE TESTED
   NO. TESTED __100__ NO. OF REJECTS __0__
   ARE RESULTS REPRESENTATIVE OF PREVIOUS LOTS?
   ☒ YES ☐ NO
3. IN PROCESS/MANUFACTURING FAILURE
   ☒ BOARD TEST ☒ SYSTEM TEST
   HOW MANY UNITS FAILED? __3__
   FAILED AFTER __0__ HOURS OF TESTING
   WAS UNIT RETESTED AT INCOMING INSPECTION?
   ☐ YES ☒ NO
   ARE RESULTS REPRESENTATIVE OF PREVIOUS LOTS?
   ☒ YES ☐ NO
4. FIELD FAILURE
   FAILED AFTER ______ HOURS OPERATION
   ESTIMATED FAILURE RATE ______% PER ______
   END USER __________ LOCATION __________
   MIN. _____°C AVE. _____°C MAX. _____°C
5. OTHER ______________________

**Action Requested by Customer:**

This section should be completed with the customer's expectations. This information is essential for an appropriate response.

**Reason for Electrical Reject:**

This section should be completed if the type of failure could be identified. If this information is contained in attached customer correspondence there is no need to transpose onto the PFAST Action Request form.

## PFAST REQUIREMENTS

The value of returning failing products is in the corrective actions that are generated. Failure to meet the following requirements can cause erroneous conclusion and corrective action; therefore, failure to meet these requirements will result in the request being returned. Contact the local PFAST Coordinator if you have any questions.

Units with conformal coating should include the coating manufacturer and model. This is requested since the coating must be removed in order to perform electrical and hermeticity testing.

1. Units must be returned with proper ESD protection (ESD-safe shipping tubes within shielding box/bag or inserted into conductive foam within shielding box/bag). No tape, paper bags, or plastic bags should be used. This requirement ensures that the devices are not damaged during shipment back to Harris.
2. Units must be intact (lid not removed and at least part of each package lead present). This is a requirement since the parts must be intact in order to perform electrical test. Also, opening the package can remove evidence of the cause of failure and lead to an incorrect conclusion.
3. Programmable parts (ROMs, PROMs, UVEPROMs, and EEPROMs) must include a master unit with the same pattern. This requirement is to provide the pattern so all failing locations can be identified. A master unit is required if a failure analysis is requested.

**FIGURE 7. PFAST ACTION REQUEST (Continued)**

## Product Analysis Lab

The Product Analysis Laboratory capabilities and charter encompass the isolation and identification of failure modes and mechanisms, preparing comprehensive technical reports, and assigning appropriate corrective actions. The primary activities of the Product Analysis Lab are electrical verification/characterization of the failure, package inspection/analysis, die inspection/analysis, and circuit isolation/probing. A variety of tools and techniques have been developed to ensure the accuracy and integrity of the product analysis. This section lists some of the tools and techniques that are employed during a typical analysis.

The electrical verification/characterization of devices failing electrical parameters is essential prior to performing an analysis. The information obtained from the electrical verification provides a direction for the analysis efforts. The following electrical verification/characterization equipment may be used to obtain electrical data on a device:

- LV500 ASIC verification system
- LTS2020 Analog tester
- Curve Tracer
- Parametric Analyzer

Prior to die level analysis, package inspection and analysis are performed. These steps are performed routinely since valuable data may not be obtainable once the package is opened. The package inspection and analysis may require the use of some of the following lab equipment:

- X-ray
- C-mode Scanning Acoustic Microscope (C-SAM)
- Optical inspection microscopes
- Package opening tools and techniques

Once the device has been opened, die inspection and analysis can be performed. Depending on the type of failure, several tools and techniques may be used to identify the failure mechanism. Usually the faster and easier to use operations are performed first in an attempt to expedite the analysis. The list of equipment and techniques for performing die inspection and analysis is as follows:

- Optical microscopes
- Liquid crystal
- Emission microscope
- Scanning electron microscopes - SEM

The final step of circuit isolation is ready to be performed when an area of the circuit has been identified as the source of the problem through one of the previous analysis efforts. Circuit analysis is performed using the following probing and isolation tools:

- Mechanical probing
- Laser cutter and isolation
- E-beam probing
- Cross sectioning and chemical deprocessing

A typical analysis flow is shown in the Figure 8 below. The exact analysis steps and sequence are determined as the situation dictates. For the analysis to be conclusive, it is essential that the failure mechanism correlates to the initial product failure conditions. Some failure mechanisms require elemental and chemical analysis to identify the root cause within the manufacturing process. Elemental and chemical analysis tasks are sent to the Analytical Services Lab for further evaluation.

The results of each analysis are entered into a computer data base. This data base is used to search for specific types of problems, to identify trends, and to verify that the corrective actions were effective.

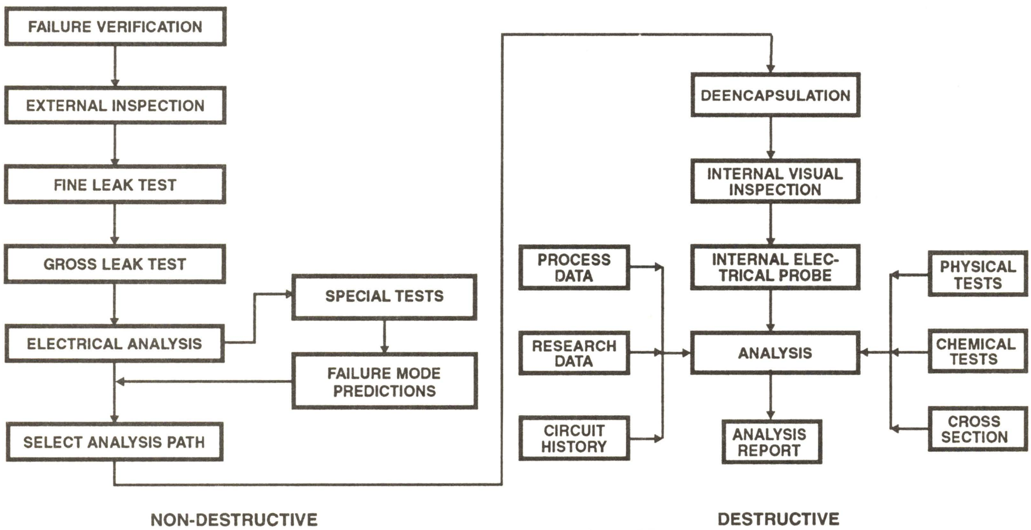



FIGURE 8. ANALYSIS SEQUENCE

## Analytical Services Laboratory

Chemical and physical analysis of materials and processes is an integral part of Harris' Total Quality/Continuous Improvement efforts to build reliability into processes and products. Manufacturing operations are supported with real-time analyses to help maintain robust processes. Analyses are run in cooperation with raw material suppliers to help them provide controlled materials in dock-to-stock procurement programs.

Harris facilities, engineering, manufacturing, and product assurance are supported by the Analytical Services Laboratory. Organized into chemical or microbeam analysis methodology, staff and instrumentation from both labs cooperate in fully integrated approaches necessary to complete analytical studies.

The department also maintains ongoing working arrangements with commercial laboratories, universities, and equipment manufacturers to obtain any materials analysis in cases where instrumental capabilities are not available in our own facility.

Figure 9 and Figure 10 show the capabilities of each area.

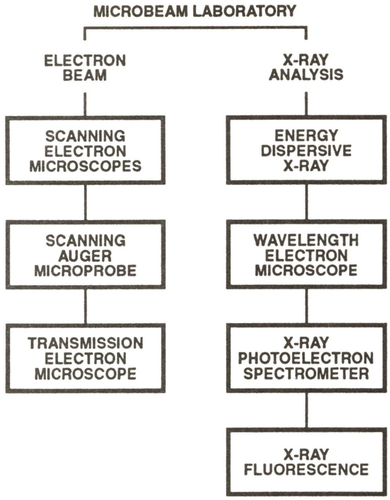



FIGURE 9. MICROBEAM LABORATORY

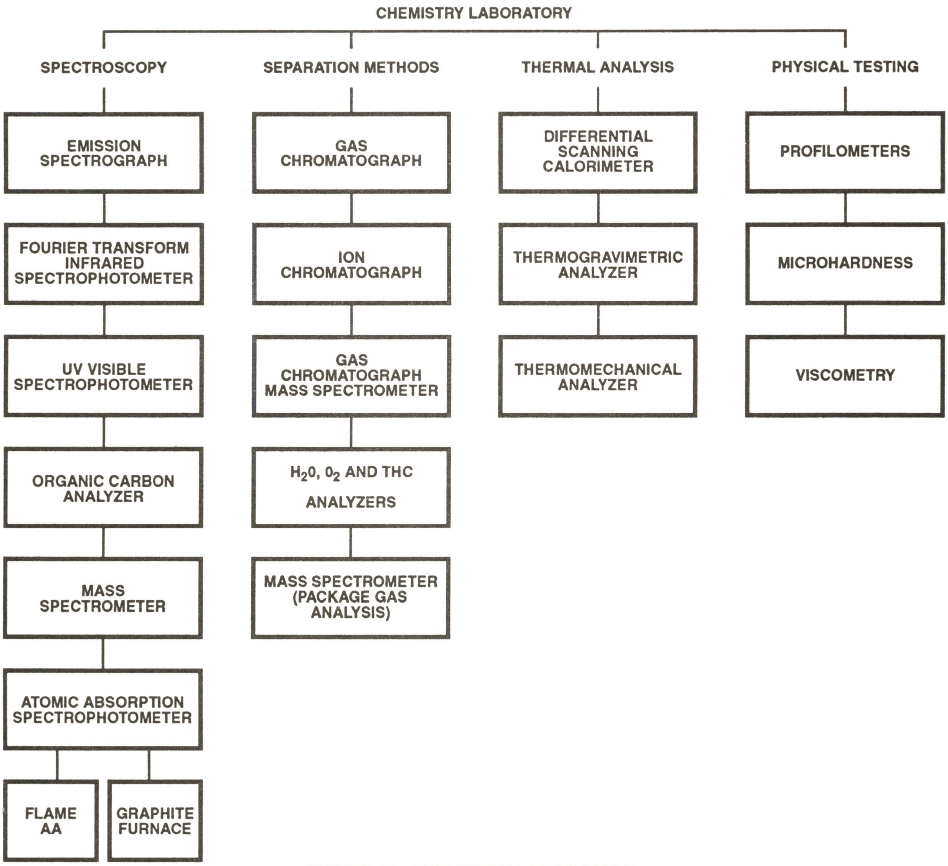



FIGURE 10. CHEMISTRY LABORATORY

## Reliability Fundamentals and Calculation of Failure Rate

Table 8 defines some of the more important terminology used in describing the lifetime of integrated circuits. Of prime importance is the concept of "failure rate" and its calculation.

### Failure Rate Calculations

Since reliability data can be accumulated from a number of different life tests with several different failure mechanisms, a comprehensive failure rate is desired. The failure rate calculation can be complicated if there are more than one failure mechanism in a life test, since the failure mechanisms are thermally activated at different rates The equation below accounts for these considerations along with a statistical factor to obtain the upper confidence level (UCL) for the resulting failure rate.

$$\lambda = \left[ \sum_{i=1}^{\beta} \frac{x_i}{\sum_{j=1}^{k} TDH_j\, AF_{ij}} \right] \times \frac{M \times 10^9}{\sum_{i=1}^{\beta} x_i}$$

where,

$\lambda$ = failure rate in FITs (Number fails in $10^9$ device hours)

$\beta$ = number of distinct possible failure mechanisms

k = number of life tests being combined

$x_i$ = number of failures for a given failure mechanism $i = 1, 2, \ldots \beta$

$TDH_j$ = Total device hours of test time (unaccelerated) for Life Test $j, j = 1, 2, 3, \ldots k$

$AF_{ij}$ = Acceleration factor for appropriate failure mechanism $i = 1, 2, \ldots k$

M = $X^2_{(\alpha,\, 2r+2)}/2$
where,
$X^2$ = chi square factor for 2r + 2 degrees of freedom
r = total number of failures ($\Sigma x_i$)
$\alpha$ = risk associated with UCL;
i.e. $\alpha$ = (100-UCL(%))/100

In the failure rate calculation, Acceleration Factors ($AF_{ij}$) are used to derate the failure rate from the thermally accelerated life test conditions to a failure rate indicative of actual use temperature. Although no standard exists, a temperature of +55°C has been popular. Harris Semiconductor Reliability Reports will derate to +55°C and will express failure rates at 60% UCL. Other derating temperatures and UCLs are available upon request.

TABLE 8. FAILURE RATE PRIMER

| TERMS | DEFINITIONS/DESCRIPTION |
|---|---|
| Failure Rate $\lambda$ | Measure of failure per unit of time. The early life failure rate is typically higher, decreases slightly, and then becomes relatively constant over time. The onset of wear-out will show an increasing failure rate, which should occur well beyond useful life. The useful life failure rate is based on the exponential life distribution. |
| FIT (Failure In Time) | Measure of failure rate in $10^9$ device hours; e.g., 1 FIT = 1 failure in $10^9$ device hours, 100 FITS = 100 failure in $10^9$ device hours, etc. |
| Device Hours | The summation of the number of units in operation multiplied by the time of operation. |
| MTTF (Mean Time To Failure) | Mean of the life distribution for the population of devices under operation or expected lifetime of an individual, MTTF = $1/\lambda$, which is the time where 63.2% of the population has failed. Example: For $\lambda$ = 10 FITS (or 10 E-9/Hr.), MTTF = $1/\lambda$ = 100 million hours. |
| Confidence Level (or Limit) | Probability level at which population failure rate estimates are derived from sample life test: 10 FITs at 95% UCL means that the population failure rate is estimated to be no more that 10 FITs with 95% certainty. The upper limit of the confidence interval is used. |
| Acceleration Factor (AF) | A constant derived from experimental data which relates the times to failure at two different stresses. The AF allows extrapolation of failure rates from accelerated test conditions to use conditions. |

### Acceleration Factors

Acceleration factor is determined from the Arrhenius Equation. This equation is used to describe physiochemical reaction rates and has been found to be an appropriate model for expressing the thermal acceleration of semiconductor failure mechanisms.

$$AF = EXP\left[\frac{E_a}{k}\left(\frac{1}{T_{USE}} - \frac{1}{T_{STRESS}}\right)\right]$$

where,

$AF =$ Acceleration Factor

$E_a =$ Thermal Activation Energy (See Table 9)

$k =$ Boltzmann's Constant ($8.63 \times 10^{-5}$ eV/°K)

Both $T_{use}$ and $T_{stress}$ (in degrees Kelvin) include the internal temperature rise of the device and therefore represent the junction temperature.

### Activation Energy

The Activation Energy ($E_a$) of a failure mechanism is determined by performing at least two tests at different levels of stress (temperature and/or voltage). The stresses will provide the time to failure ($t_f$) for the two (or more) populations thus allowing the simultaneous solution for the activation energy as follows:

$$\ln\ (t_{f1}) = C + \frac{E_a}{kT_1} \qquad \ln\ (t_{f2}) = C + \frac{E_a}{kT_2}$$

By subtracting the two equations and solving for the activation energy, the following equation is obtained:

$$E_a = \frac{k[\ln(t_{f1}) - \ln(t_{f2})]}{(1/T1 - 1/T2)}$$

where,

$E_a =$ Thermal Activation Energy (See Table 10)

$k =$ Boltzmann's Constant ($8.63 \times 10^{-5}$ eV/°K)

$T_1, T_2 =$ Life test temperatures in degrees Kelvin

**TABLE 9. FAILURE MECHANISM**

| FAILURE MECHANISM | ACTIVATION ENERGY | SCREENING AND TESTING METHODOLOGY | CONTROL METHODOLOGY |
|---|---|---|---|
| Oxide Defects | 0.3eV - 0.5eV | High temperature operating life (HTOL) and voltage stress. Defect density test vehicles. | Statistical Process Control of oxide parameters, defect density control, and voltage stress testing. |
| Silicon Defects (Bulk) | 0.3eV - 0.5eV | HTOL and voltage stress screens. | Vendor statistical Quality Control programs, and Statistical Process Control on thermal processes. |
| Corrosion | 0.45eV | Highly accelerated stress testing (HAST) | Passivation dopant control, hermetic seal control, improved mold compounds, and product handling. |
| Assembly Defects | 0.5eV - 0.7eV | Temperature cycling, temperature and mechanical shock, and environmental stressing. | Vendor Statistical Quality Control programs, Statistical Process Control of assembly processes, proper handling methods. |
| Electromigration<br>- Al Line<br>- Contact | <br>0.6eV<br>0.9eV | Test vehicle characterizations at highly elevated temperatures. | Design ground rules, wafer process statistical process steps, photoresist, metals and passivation. |
| Mask Defects/ Photoresist Defects | 0.7eV | Mask FAB comparator, print checks, defect density monitor in FAB, voltage stress test and HTOL. | Clean room control, clean mask, pellicles, Statistical Process Control of photoresist/etch processes. |
| Contamination | 1.0eV | C-V stress at oxide/interconnect, wafer FAB device stress test and HTOL. | Statistical Process Control of C-V data, oxide/ interconnect cleans, high integrity glassivation and clean assembly processes. |
| Charge Injection | 1.3eV | HTOL and oxide characterization. | Design ground rules, wafer level Statistical Process Control and critical dimensions for oxides. |

# ELECTROSTATIC DISCHARGE CONTROL: A GUIDE TO HANDLING INTEGRATED CIRCUITS

This paper discusses methods and materials recommended for protection of ICs against ESD damage or degradation during manufacturing operations vulnerable to ESD exposure. Areas of concern include dice prep and handling, dice and package inspection, packing, shipping, receiving, testing, assembly and all operations wurhere ICs are involved.

All integrated circuits are sensitive to electrostatic discharge (ESD) to some degree. Since the introduction of integrated circuits with MOS structures and high quality junctions, safe and effective means of handling these devices have been of primary importance.

If static discharge occurs at a sufficient magnitude, 2kV or greater, some damage or degradation will usually occur. It has been found that handling equipment and personnel can generate static potentials in excess of 10kV in a low humidity environment; thus it becomes necessary for additional measures to be implemented to eliminate or reduce static charge. Avoiding any damage or degradation by ESD when handling devices during the manufacturing flow is therefore essential.

## ESD Protection and Prevention Measures

One method employed to protect gate oxide structures is to incorporate input protection diodes directly on the monolithic chip. However, there is no completely foolproof system of chip input protection in existence in the industry.

In areas where ICs are being handled, certain equipment should be utilized to reduce the damaging effects of ESD. Typically, equipment such as grounded work stations, conductive wrist straps, conductive floor mats, ionized air blowers and conductive packaging materials are included in the IC handling environment. Any time an individual intends to handle an IC, in any way, they must insure they have been grounded to eliminate circuit damage.

Grounding personnel can, practically, be performed by two methods. First, grounded wrist straps which are usually made of a conductive material, such as Velostat or metal. A resistor value of 1 megohm (1/2 watt) in series with the strap to ground completes a discharge path for ESD when the operator wears the strap in contact with the skin. Another method is to insure direct physical contact with a grounded, conductive work surface.

This consists of a conductive surface like Velostat, covering the work area. The surface is connected to a 1 megohm (1/2 watt) resistor in series with ground.

In addition to personnel grounding, areas where work is being performed with ICs, should be equipped with an ionized air blower. Ionized air blowers force positive and negative ions simultaneously over the work area so that any nonconductors that are near the work surface would have their static charge neutralized before it would cause device damage or degradation.

Relative humidity in the work area should be maintained as high as practical. When the work environment is less than 40% RH, a static build-up condition can exist on nonconductors allowing stored charges to remain near the ICs causing possible static electricity discharge to ICs.

Integrated circuits that are being shipped or transported require special handling and packaging materials to eliminate ESD damage. Dice or packaged devices should be in conductive carriers during all phases of transport and handling. Leads of packaged devices can be shorted by tubular metallic carriers, conductive foam or foil.

## Do's and Don'ts for Integrated Circuit Handling

### Do's

Do keep paper, nonconductive plastic, plastic foams and films or cardboard off the static controlled conductive bench top. Placing devices, loaded sticks or loaded burn-in boards on top of any of these materials effectively insulates them from ground and defeats the purpose of the static controlled conductive surface.

Do keep hand creams and food away from static controlled conductive work surfaces. If spilled on the bench top, these materials will contaminate and increase the resistivity of the work area.

Do be especially careful when using soldering guns around conductive work surfaces. Solder spills and heat from the gun may melt and damage the conductive mat.

Do check the grounded wrist strap connections daily. Make certain they are snugly fitted before starting work with the product.

Do put on grounded wrist strap before touching any devices. This drains off any static build-up from the operator.

Do know the ESD caution symbols.

Do remove devices or loaded sticks from shielding bags only when grounded via wrist strap at grounded work station. This also applies when loading or removing devices from the antistatic sticks or the loading on or removing from the burn-in boards.

Do wear grounded wrist straps in direct contact with the bare skin never over clothing.

Do use the same ESD control with empty burn-in boards as with loaded boards if boards contain permanently mounted ICs as part of driver circuits.

Do insure electrical test equipment and solder irons at an ESD control station are grounded and only uninsulated metal hand tools be used. Ordinary plastic solder suckers and other plastic assembly aids shall not be used.

Do use ionizing air blowers in static controlled areas when the use of plastic (nonconductive) materials cannot be avoided.

**Don'ts**

Don't allow anyone not grounded to touch devices, loaded sticks or loaded burn-in boards. To be grounded they must be standing on a conductive floor mat with conductive heel straps attached to footwear or must wear a grounded wrist strap.

Don't touch the devices by the pins or leads unless grounded since most ESD damage is done at these points.

Don't handle devices or loaded sticks during transport from work station to work station unless protected by shielding bags. These items must never be directly handled by anyone not grounded.

Don't use freon or chlorinated cleaners at a grounded work area.

Don't wax grounded static controlled conductive floor and bench top mats. This would allow build-up of an insulating layer and thus defeating the purpose of a conductive work surface.

Don't touch devices or loaded sticks or loaded burn-in boards with clothing or textiles even though grounded wrist strap is worn. This does not apply if conductive coats are worn.

Don't allow personnel to be attached to hard ground. There must always be 1 megohm series resistance (1/2 watt between the person and the ground).

Don't touch edge connectors of loaded burn-in boards or empty burn-in boards containing permanently mounted driver circuits when not grounded. This also applies to burn-in programming cards containing ICs.

Don't unload stick on a metal bench top allowing rapid discharge of charged devices.

Don't touch leads. Handle devices by their package even though grounded.

Don't allow plastic "snow or peanut" polystyrene foam or other high dielectric materials to come in contact with devices or loaded sticks or loaded burn-in boards.

Don't allow rubber/plastic floor mats in front of static controlled work benches.

Don't solvent-clean devices when loaded in antistatic sticks since this will remove antistatic inner coating from sticks.

Don't use antistatic sticks for more than one throughput process. Used sticks should not be reused unless recoated.

## Recommended Maintenance Procedures

**Daily**

Perform visual inspection of ground wires and terminals on floor mats, bench tops, and grounding receptacles to ensure that proper electrical connections via 1 megohm resistor (1/2 watt) exist.

Clean bench top mats with a soft cloth or paper towel dampened with a mild solution of detergent and water.

**Weekly**

Damp mop conductive floor mats to remove any accumulated dirt layer which causes high resistivity.

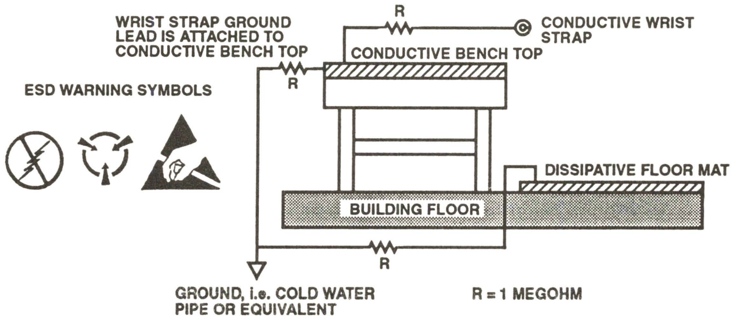
**Annually**

Replace nuclear elements for ionized air blowers.

Review ESD protection procedures and equipment for updating and adequacy.

## Static Controlled Work Station

The figure below shows an example of a work bench properly equipped to control electro-static discharge. Note that the wrist strap is connected to a 1 megohm resistor. This resistor can be omitted in the setup if the wrist strap has a 1 megohm assembled on the cable attached.



# ANALOG 11

## SPICE MODEL LISTING

| PART NUMBER | DESCRIPTION |
|---|---|
| HA-2500 | Precision, High Slew Rate, Single Op Amp |
| HA-2502 | Precision, High Slew Rate, Single Op Amp |
| HA-2510 | High Slew Rate, Single Op Amp |
| HA-2512 | High Slew Rate, Single Op Amp |
| HA-2520 | Uncompensated, High Slew Rate, Single Op Amp |
| HA-2522 | Uncompensated, High Slew Rate, Single Op Amp |
| HA-2539 | Very High Slew Rate, Wideband, Single Op Amp |
| HA-2540 | Wideband, Fast Settling, +10 Stable Single Op Amp |
| HA-2541 | Wideband, Fast Settling, Unity Gain Stable, Op Amp |
| HA-2542 | Wideband, High Slew Rate, High Output Current +2 Stable Op Amp |
| HA-2544 | Precision, High Slew Rate, Unity Gain Stable Op Amp |
| HA-2548 | Precision, High Slew Rate, Wideband +5 Stable Op Amp |
| HA-2600 | Wideband, High Input Impedance, Single Op Amp |
| HA-2602 | Wideband, High Input Impedance, Single Op Amp |
| HA-2620 | Very Wideband, Uncompensated, Single Op Amp |
| HA-2622 | Very Wideband, Uncompensated, Single Op Amp |
| HA-2839 | Very High Slew Rate, Wideband, +10 Stable Single Op Amp |
| HA-2840 | Very High Slew Rate, Wideband, +10 Stable Single Op Amp |
| HA-2841 | Wideband, Fast Settling, Unity Gain Stable Video Amp |
| HA-2842 | Wideband, High Slew Rate, High Output Current +2 Stable Video Amp |
| HA-2850 | Low Power, High Slew Rate, Wideband, +10 Stable Single Op Amp |
| HA-5002 | Wideband, High Slew Rate, 200mA Output Current Buffer |
| HA-5004 | 100MHz Current Feedback, Single Video Op Amp |
| HA-5020 | 100MHz Current Feedback, Single Video Op Amp |
| HA-5033 | 250MHz, 100mA Output Current Video Buffer |
| HA-5101 | Low Noise, High Performance, Single Op Amp |
| HA-5102 | Low Noise, High Performance, Dual Op Amp |
| HA-5104 | Low Noise, High Performance, Quad Op Amp |
| HA-5112 | Low Noise, High Performance, Dual Op Amp |
| HA-5114 | Low Noise, High Performance, Quad Op Amp |
| HA-5127 | Low Noise, Precision, Unity Gain Stable, Single Op Amp |
| HA-5137 | Low Noise, Precision, +5 Stable, Single Op Amp |
| HA-5147 | Low Noise, Precision, +10 Stable, Single Op Amp |
| HA-5190 | Wideband, Fast Settling, Single Op Amp |
| HA-5221 | Low Noise, Wideband, Precision, Single Op Amp |
| HA-5222 | Low Noise, Wideband, Precision, Dual Op Amp |
| HC-5509B | Subscriber Line Interface IC (SLIC) |
| HFA3XXX | 10GHz NPN, 5.5GHz PNP Transistor Arrays |
| HFA1100 | 850MHz Current Feedback Op Amp |

# ANALOG 12

## PACKAGING INFORMATION

PAGE

# Analog Military Package Selection Guide

**Using the Selection Guide:**

The first character of each entry indicates the package type, while the number preceding the decimal point details the package lead count. Except for LCC and Can packages, the decimal point and succeeding numbers specify the reference package width in inches (e.g. .3 = 300 mil width). The entire entry indicates the package table containing the appropriate package dimensions (e.g. 16 lead CerDIP dimensions are detailed in Table F16.3). The index on page 11-1 lists page numbers for CerDIP, Sidebraze, LCC, and Can tables.

NOTE: Parts listed with /883 or /883B suffix are MIL-STD-883 compliant. All other products are specified over the military temperature range.

| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| AD7520/883B | | F16.3 | | |
| AD7545 | | F20.3 | | |
| ADC0802 | | F20.3 | | |
| ADC0803 | | F20.3 | | |
| DG200/883B | | F14.3 | | T10.B |
| DG201/883B | | F16.3 | | |
| DG201A/883B | | F16.3 | | |
| DG202/883B | | F16.3 | | |
| DG300A/883B | | F14.3 | | T10.B |
| DG301A/883B | | F14.3 | | T10.B |
| DG302A/883B | | F14.3 | | |
| DG303A/883B | | F14.3 | | |
| DG308A/883B | | F16.3 | | |
| DG309/883B | | F16.3 | | |
| DG401/883 | | F16.3 | | |
| DG403/883 | | F16.3 | | |
| DG405/883 | | F16.3 | | |
| DG408/883 | | F16.3 | | |
| DG409/883 | | F16.3 | | |
| DG411/883 | | F16.3 | | |
| DG412/883 | | F16.3 | | |
| DG413/883 | | F16.3 | | |
| DG441/883 | | F16.3 | | |
| DG442/883 | | F16.3 | | |
| DG458/883 | | F16.3 | | |
| DG459/883 | | F16.3 | | |
| DG506A/883B | | F28.6 | | |
| DG507A/883B | | F28.6 | | |
| DG508A/883B | | F16.3 | | |

| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| DG509A/883B | | F16.3 | | |
| DG526/883B | | F28.6 | | |
| DG527/883B | | F28.6 | | |
| DG528/883B | | F18.3 | | |
| DG529/883B | | F18.3 | | |
| HA-2400/883 | | F16.3 | J20.A | |
| HA-2420/883 | | F14.3 | J20.A | |
| HA-2444/883 | | F16.3 | | |
| HA-2500/883 | | F8.3A | | T8.C |
| HA-2502/883 | | F8.3A | J20.A | T8.C |
| HA-2510/883 | | F8.3A | | T8.C |
| HA-2512/883 | | F8.3A | J20.A | T8.C |
| HA-2520/883 | | F8.3A | | T8.C |
| HA-2522/883 | | F8.3A | J20.A | T8.C |
| HA-2529/883 | | F8.3A | J20.A | T8.C |
| HA-2539/883 | | F14.3 | J20.A | |
| HA-2540/883 | | F14.3 | J20.A | |
| HA-2541/883 | | | | T12.C |
| HA-2542/883 | | | | T12.C |
| HA-2544/883 | | F8.3A | J20.A | T8.C |
| HA-2546/883 | | F16.3 | J20.A | |
| HA-2548/883 | D8.3 | | | T8.C |
| HA-2556/883 | | F16.3 | | |
| HA-2557/883 | | F16.3 | | |
| HA-2600/883 | | F8.3A | | T8.C |
| HA-2602/883 | | F8.3A | | T8.C |
| HA-2620/883 | | F8.3A | | T8.C |
| HA-2622/883 | | F8.3A | | T8.C |
| HA-2640/883 | | F8.3A | J20.A | T8.C |

**EXAMPLE:** F 16 .3

PACKAGE TYPE — F; LEAD COUNT — 16; BODY WIDTH — .3

| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| HA-2700 | | F14.3 | | T8.C |
| HA-2839/883 | | F14.3 | | |
| HA-2840/883 | | F8.3A, F14.3 | | |
| HA-2841/883 | | F8.3A, F14.3 | | |
| HA-2842/883 | | F8.3A, F14.3 | | |
| HA-2850/883 | | F8.3A, F14.3 | | |
| HA-4741/883 | | F14.3 | J20.A | |
| HA-4900 | | F16.3 | | |
| HA-4902/883 | | F16.3 | J20.A | |
| HA-5002/883 | | F8.3A | J20.A | T8.C |
| HA-5004/883 | | F14.3 | | |
| HA-5020/883 | | F8.3A | J20.A | |
| HA5022/883 | | F16.3 | | |
| HA5023/883 | | F8.3A | | |
| HA-5033/883 | | | | T12.C |
| HA-5101/883 | | F8.3A | J20.A | T8.C |
| HA-5102/883 | | F8.3A | J20.A | T8.C |
| HA-5104/883 | | F14.3 | J20.A | |
| HA-5111/883 | | F8.3A | J20.A | T8.C |
| HA-5112/883 | | F8.3A | J20.A | T8.C |
| HA-5114/883 | | F14.3 | J20.A | |
| HA-5127/883 | | F8.3A | J20.A | T8.C |
| HA-5127A | | F8.3A | | T8.C |
| HA-5130 | | F8.3A | | T8.C |
| HA-5134/883 | | F14.3 | J20.A | |
| HA-5135/883 | | F8.3A | J20.A | T8.C |
| HA-5137/883 | | F8.3A | J20.A | T8.C |
| HA-5137A | | F8.3A | | T8.C |
| HA-5142/883 | | F8.3A | J20.A | T8.C |
| HA-5144/883 | | F14.3 | J20.A | |
| HA-5147/883 | | F8.3A | J20.A | T8.C |
| HA-5147A | | F8.3A | | T8.C |
| HA-5160 | | | | T8.C |
| HA-5170 | | F8.3A | | T8.C |

| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| HA-5177/883 | | F8.3A | J20.A | T8.C |
| HA-5190/883 | | F14.3 | J20.A | T12.C |
| HA-5221/883 | | F8.3A | J20.A | T8.C |
| HA-5222/883 | | F8.3A | J20.A | |
| HA-5320/883 | | F14.3 | J20.A | |
| HA-5330/883 | | F14.3 | J20.A | |
| HA-5340/883 | | F14.3 | J20.A | |
| HA5351/883 | | F8.3A | | |
| HA5352/883 | | F14.3 | | |
| HC55564/883 | | F14.3 | J20.A | |
| HFA1100/883 | | F8.3A | | |
| HFA1110/883 | | F8.3A | | |
| HFA1112/883 | | F8.3A | | |
| HFA1113/883 | | F8.3A | J20.A | |
| HFA1115/883 | | F8.3A | | |
| HFA1120/883 | | F8.3A | | |
| HFA1130/883 | | F8.3A | J20.A | |
| HFA1135/883 | | F8.3A | J20.A | |
| HFA1145/883 | | F8.3A | | |
| HI-200/883 | | F14.3 | | T10.B |
| HI-201/883 | | F16.3 | J20.A | |
| HI-201HS/883 | | F16.3 | J20.A | |
| HI-222/883 | | F14.3 | J20.A | |
| HI-300/883 | | F14.3 | | T10.B |
| HI-301/883 | | F14.3 | | T10.B |
| HI-302/883 | | F14.3 | | |
| HI-303/883 | | F14.3 | | |
| HI-304/883 | | F14.3 | | T10.B |
| HI-305/883 | | F14.3 | | T10.B |
| HI-306/883 | | F14.3 | | |
| HI-307/883 | | F14.3 | | |
| HI-381/883 | | F14.3 | | T10.B |
| HI-384/883 | | F16.3 | | |
| HI-387/883 | | F14.3 | | T10.B |
| HI-390/883 | | F16.3 | | |
| HI-506/883 | | F28.6 | J28.A | |
| HI-507/883 | | F28.6 | J28.A | |

EXAMPLE: F 16 .3

PACKAGE TYPE (F) — LEAD COUNT (16) — BODY WIDTH (.3)

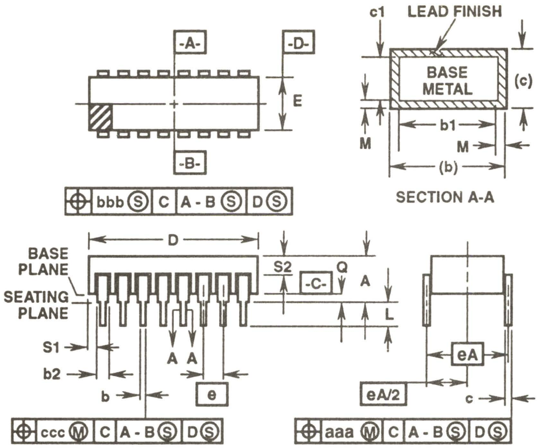
| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| HI-508/883 | | F16.3 | J20.A | |
| HI-509/883 | | F16.3 | J20.A | |
| HI-516/883 | | F28.6 | J28.A | |
| HI-518 | | F18.3 | J20.A | |
| HI-524/883 | | F18.3 | J20.A | |
| HI-539/883 | | F16.3 | | |
| HI-546/883 | | F28.6 | J28.A | |
| HI-547/883 | | F28.6 | J28.A | |
| HI-548/883 | | F16.3 | J20.A | |
| HI-549/883 | | F16.3 | J20.A | |
| HI-565A/883 | | F24.6 | | |
| HI-574A/883 | D28.6 | | J44.A | |
| HI-674A/883 | D28.6 | | J44.A | |
| HI-774/883 | D28.6 | | J44.A | |
| HI-1818A/883 | | F16.3 | | |
| HI-1828A/883 | | F16.3 | J20.A | |
| HI-5040/883 | | F16.3 | | |
| HI-5041/883 | | F16.3 | | |
| HI-5042/883 | | F16.3 | | |
| HI-5043/883 | | F16.3 | J20.A | |
| HI-5044/883 | | F16.3 | | |
| HI-5045/883 | | F16.3 | | |
| HI-5046/883 | | F16.3 | | |
| HI-5046A/883 | | F16.3 | | |
| HI-5047/883 | | F16.3 | | |

| PART NUMBER | SIDE-BRAZE | CERDIP | LCC | CAN |
|---|---|---|---|---|
| HI-5047A/883 | | F16.3 | | |
| HI-5048/883 | | F16.3 | | |
| HI-5049/883 | | F16.3 | | |
| HI-5050/883 | | F16.3 | | |
| HI-5051/883 | | F16.3 | J20.A | |
| HI-5700/883 | | F28.6 | | |
| HI-5701/883 | | F18.3 | | |
| HI7153/883 | D40.6 | | | |
| ICL232/883B | | F16.3 | | |
| ICL8038/883B | | F14.3 | | |
| ICL8069/883B | | | | T2.A |
| ICM7170/883B | D24.6 | | | |
| ICM7228/883B | | F28.6 | | |
| ICM7555/883B | | | | T8.C |
| ICM7556/883B | | F14.3 | | |
| IH5043/883B | | F16.3 | | |
| IH5140/883B | | F16.3 | | |
| IH5141/883B | | F16.3 | | |
| IH5142/883B | | F16.3 | | |
| IH5143/883B | | F16.3 | | |
| IH5144/883B | | F16.3 | | |
| IH5145/883B | | F16.3 | | |
| IH5151/883B | | F16.3 | | |
| IH5341/883B | | | | T10.B |
| IH5352/883B | | F16.3 | | |

EXAMPLE: F 16 .3

PACKAGE TYPE — F; LEAD COUNT — 16; BODY WIDTH — .3

## Ceramic Dual-In-Line Metal Seal Packages (SBDIP)




### D8.3 MIL-STD-1835 CDIP2-T8 (D-4, CONFIGURATION C)
### 8 LEAD CERAMIC DUAL-IN-LINE METAL SEAL PACKAGE

| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.405 | - | 10.29 | - |
| E | 0.220 | 0.310 | 5.59 | 7.87 | - |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 5 |
| S1 | 0.005 | - | 0.13 | - | 6 |
| S2 | 0.005 | - | 0.13 | - | 7 |
| $\alpha$ | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2 |
| N | 8 | | 8 | | 8 |

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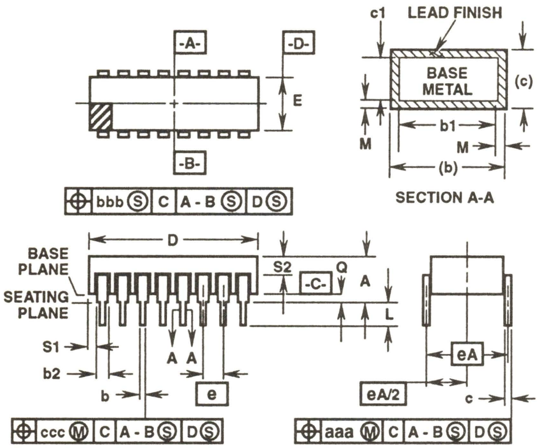
NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. Dimension Q shall be measured from the seating plane to the base plane.
6. Measure dimension S1 at all four corners.
7. Measure dimension S2 from the top of the ceramic body to the nearest metallization or lead.
8. N is the maximum number of terminal positions.
9. Braze fillets shall be concave.
10. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
11. Controlling dimension: INCH.
12. Materials: Compliant to MIL-I-38535.

## Ceramic Dual-In-Line Metal Seal Packages (SBDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. Dimension Q shall be measured from the seating plane to the base plane.
6. Measure dimension S1 at all four corners.
7. Measure dimension S2 from the top of the ceramic body to the nearest metallization or lead.
8. N is the maximum number of terminal positions.
9. Braze fillets shall be concave.
10. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
11. Controlling dimension: INCH.
12. Materials: Compliant to MIL-I-38535.

**D24.6** MIL-STD-1835 CDIP2-T24 (D-3, CONFIGURATION C)
24 LEAD CERAMIC DUAL-IN-LINE METAL SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.225 | - | 5.72 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 1.290 | - | 32.77 | - |
| E | 0.500 | 0.610 | 12.70 | 15.49 | - |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.600 BSC | | 15.24 BSC | | - |
| eA/2 | 0.300 BSC | | 7.62 BSC | | - |
| L | 0.120 | 0.200 | 3.05 | 5.08 | - |
| Q | 0.015 | 0.075 | 0.38 | 1.91 | 5 |
| S1 | 0.005 | - | 0.13 | - | 6 |
| S2 | 0.005 | - | 0.13 | - | 7 |
| $\alpha$ | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2 |
| N | 24 | | 24 | | 8 |

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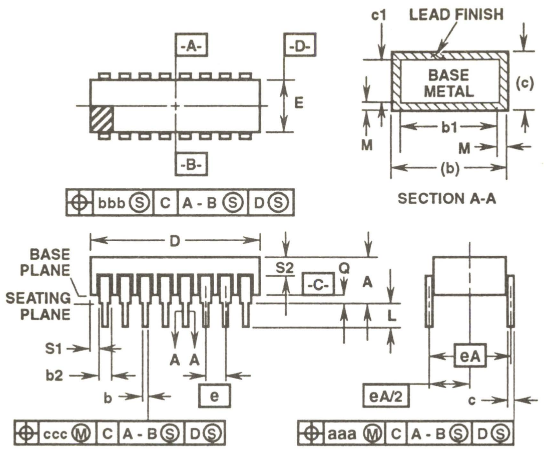
## *Ceramic Dual-In-Line Metal Seal Packages (SBDIP)*




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. Dimension Q shall be measured from the seating plane to the base plane.
6. Measure dimension S1 at all four corners.
7. Measure dimension S2 from the top of the ceramic body to the nearest metallization or lead.
8. N is the maximum number of terminal positions.
9. Braze fillets shall be concave.
10. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
11. Controlling dimension: INCH.
12. Materials: Compliant to MIL-I-38535.

**D28.6** MIL-STD-1835 CDIP2-T28 (D-10, CONFIGURATION C)
**28 LEAD CERAMIC DUAL-IN-LINE METAL SEAL PACKAGE**

| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | - | 0.232 | - | 5.92 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 1.490 | - | 37.85 | - |
| E | 0.500 | 0.610 | 12.70 | 15.49 | - |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.600 BSC | | 15.24 BSC | | - |
| eA/2 | 0.300 BSC | | 7.62 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 5 |
| S1 | 0.005 | - | 0.13 | - | 6 |
| S2 | 0.005 | - | 0.13 | - | 7 |
| $\alpha$ | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2 |
| N | 28 | | 28 | | 8 |

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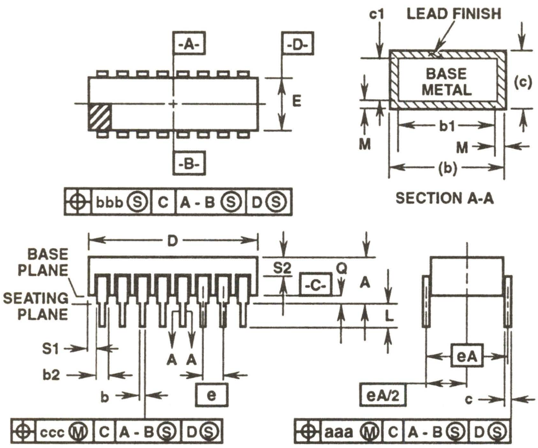
## Ceramic Dual-In-Line Metal Seal Packages (SBDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. Dimension Q shall be measured from the seating plane to the base plane.
6. Measure dimension S1 at all four corners.
7. Measure dimension S2 from the top of the ceramic body to the nearest metallization or lead.
8. N is the maximum number of terminal positions.
9. Braze fillets shall be concave.
10. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
11. Controlling dimension: INCH.
12. Materials: Compliant to MIL-I-38535.

### D40.6 MIL-STD-1835 CDIP2-T40 (D-5, CONFIGURATION C)
### 40 LEAD CERAMIC DUAL-IN-LINE METAL SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.225 | - | 5.72 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 2.096 | - | 53.24 | 4 |
| E | 0.510 | 0.620 | 12.95 | 15.75 | 4 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.600 BSC | | 15.24 BSC | | - |
| eA/2 | 0.300 BSC | | 7.62 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.070 | 0.38 | 1.78 | 5 |
| S1 | 0.005 | - | 0.13 | - | 6 |
| S2 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2 |
| N | 40 | | 40 | | 8 |

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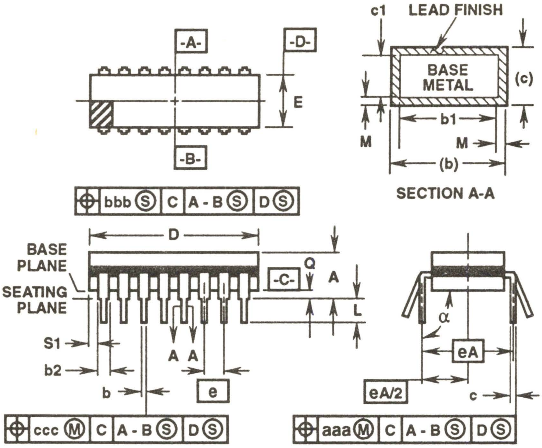
## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

### F8.3A MIL-STD-1835 GDIP1-T8 (D-4, CONFIGURATION A)
### 8 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.405 | - | 10.29 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 8 | | 8 | | 8 |

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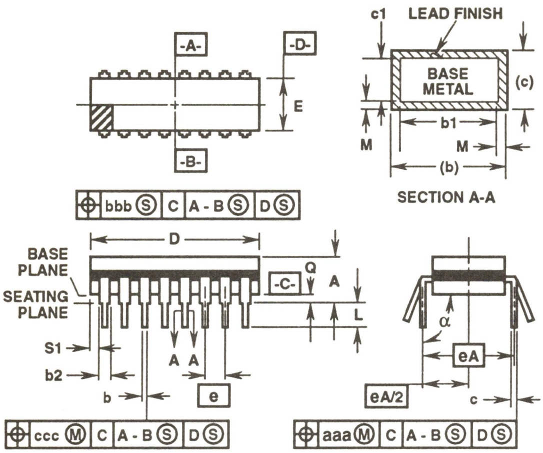
## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

**F14.3** MIL-STD-1835 GDIP1-T14 (D-1, CONFIGURATION A)
14 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE)

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.785 | - | 19.94 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 14 | | 14 | | 8 |

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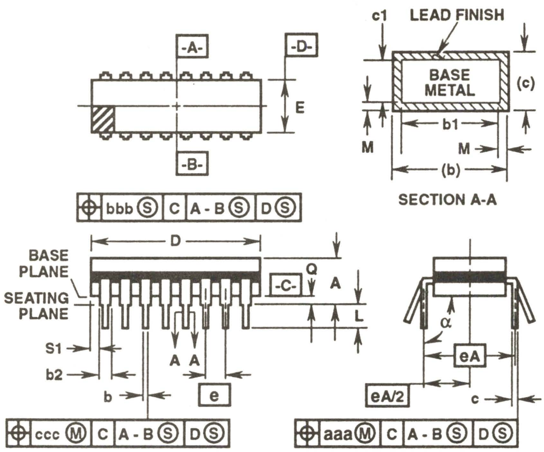
## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




**F16.3** MIL-STD-1835 GDIP1-T16 (D-2, CONFIGURATION A)
16 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.840 | - | 21.34 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 16 | | 16 | | 8 |

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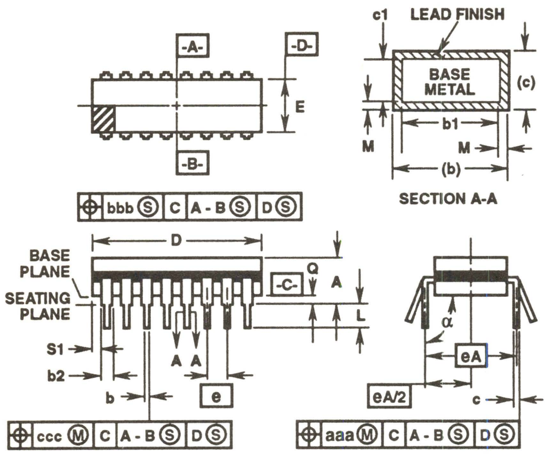
NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

### F18.3 MIL-STD-1835 GDIP1-T18 (D-6, CONFIGURATION A)
### 18 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 0.960 | - | 24.38 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.070 | 0.38 | 1.78 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 18 | | 18 | | 8 |

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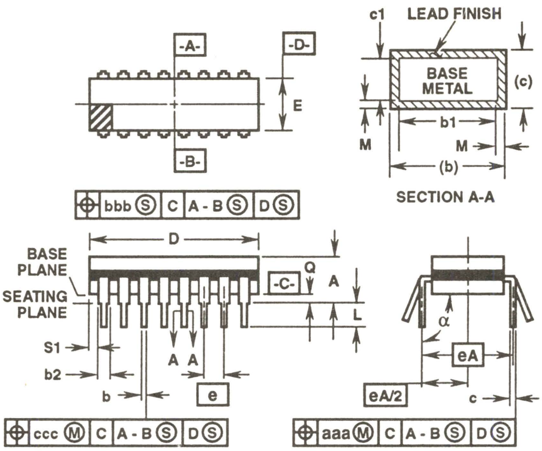
## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




**F20.3** MIL-STD-1835 GDIP1-T20 (D-8, CONFIGURATION A)
20 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | - | 0.200 | - | 5.08 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 1.060 | - | 26.92 | 5 |
| E | 0.220 | 0.310 | 5.59 | 7.87 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | - |
| eA/2 | 0.150 BSC | | 3.81 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.070 | 0.38 | 1.78 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 20 | | 20 | | 8 |

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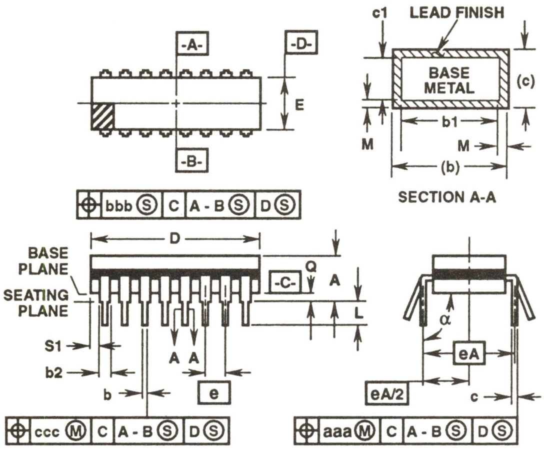
NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




### F24.6 MIL-STD-1835 GDIP1-T24 (D-3, CONFIGURATION A)
### 24 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.225 | - | 5.72 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 1.290 | - | 32.77 | 5 |
| E | 0.500 | 0.610 | 12.70 | 15.49 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.600 BSC | | 15.24 BSC | | - |
| eA/2 | 0.300 BSC | | 7.62 BSC | | - |
| L | 0.120 | 0.200 | 3.05 | 5.08 | - |
| Q | 0.015 | 0.075 | 0.38 | 1.91 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 24 | | 24 | | 8 |

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NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.

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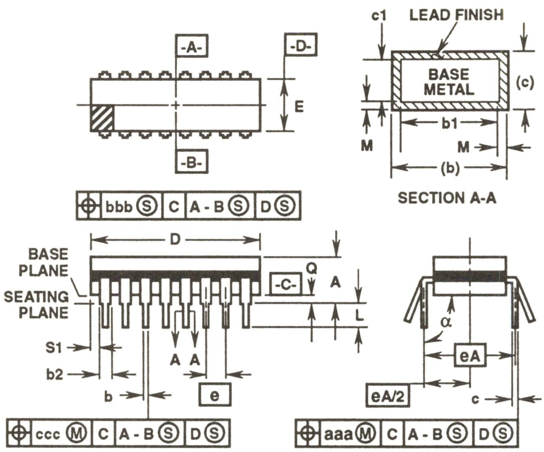
PACKAGING INFORMATION

## Ceramic Dual-In-Line Frit Seal Packages (CerDIP)




NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.
11. Materials: Compliant to MIL-I-38535.

**F28.6** MIL-STD-1835 GDIP1-T28 (D-10, CONFIGURATION A)
28 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.232 | - | 5.92 | - |
| b | 0.014 | 0.026 | 0.36 | 0.66 | 2 |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | 3 |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| b3 | 0.023 | 0.045 | 0.58 | 1.14 | 4 |
| c | 0.008 | 0.018 | 0.20 | 0.46 | 2 |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | 3 |
| D | - | 1.490 | - | 37.85 | 5 |
| E | 0.500 | 0.610 | 12.70 | 15.49 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.600 BSC | | 15.24 BSC | | - |
| eA/2 | 0.300 BSC | | 7.62 BSC | | - |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | 6 |
| S1 | 0.005 | - | 0.13 | - | 7 |
| α | 90° | 105° | 90° | 105° | - |
| aaa | - | 0.015 | - | 0.38 | - |
| bbb | - | 0.030 | - | 0.76 | - |
| ccc | - | 0.010 | - | 0.25 | - |
| M | - | 0.0015 | - | 0.038 | 2, 3 |
| N | 28 | | 28 | | 8 |

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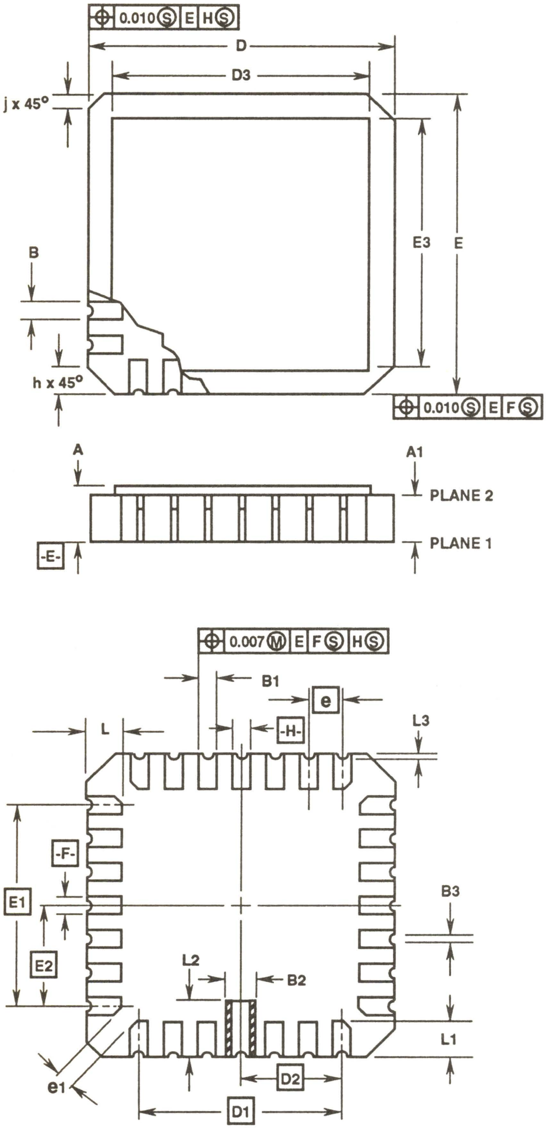
## Ceramic Leadless Chip Carrier Packages (CLCC)




### J20.A MIL-STD-1835 CQCC1-N20 (C-2)

**20 PAD CERAMIC LEADLESS CHIP CARRIER PACKAGE**

| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | 0.060 | 0.100 | 1.52 | 2.54 | 6, 7 |
| A1 | 0.050 | 0.088 | 1.27 | 2.23 | - |
| B | - | - | - | - | - |
| B1 | 0.022 | 0.028 | 0.56 | 0.71 | 2, 4 |
| B2 | 0.072 REF | | 1.83 REF | | - |
| B3 | 0.006 | 0.022 | 0.15 | 0.56 | - |
| D | 0.342 | 0.358 | 8.69 | 9.09 | - |
| D1 | 0.200 BSC | | 5.08 BSC | | - |
| D2 | 0.100 BSC | | 2.54 BSC | | - |
| D3 | - | 0.358 | - | 9.09 | 2 |
| E | 0.342 | 0.358 | 8.69 | 9.09 | - |
| E1 | 0.200 BSC | | 5.08 BSC | | - |
| E2 | 0.100 BSC | | 2.54 BSC | | - |
| E3 | - | 0.358 | - | 9.09 | 2 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| e1 | 0.015 | - | 0.38 | - | 2 |
| h | 0.040 REF | | 1.02 REF | | 5 |
| j | 0.020 REF | | 0.51 REF | | 5 |
| L | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L1 | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L2 | 0.075 | 0.095 | 1.91 | 2.41 | - |
| L3 | 0.003 | 0.015 | 0.08 | 0.38 | - |
| ND | 5 | | 5 | | 3 |
| NE | 5 | | 5 | | 3 |
| N | 20 | | 20 | | 3 |

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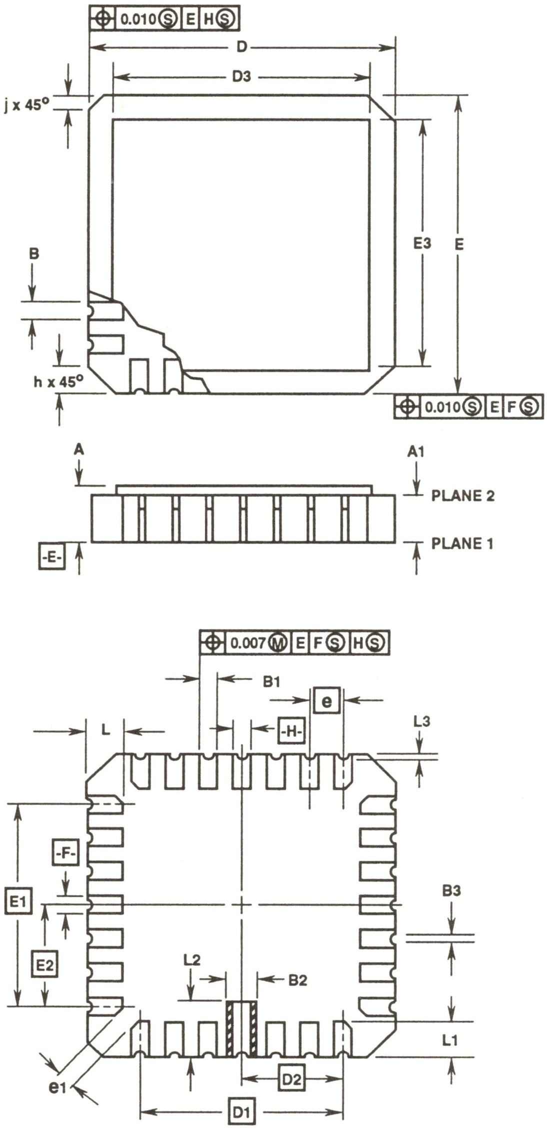
NOTES:

1. Metallized castellations shall be connected to plane 1 terminals and extend toward plane 2 across at least two layers of ceramic or completely across all of the ceramic layers to make electrical connection with the optional plane 2 terminals.
2. Unless otherwise specified, a minimum clearance of 0.015 inch (0.38mm) shall be maintained between all metallized features (e.g., lid, castellations, terminals, thermal pads, etc.)
3. Symbol "N" is the maximum number of terminals. Symbols "ND" and "NE" are the number of terminals along the sides of length "D" and "E", respectively.
4. The required plane 1 terminals and optional plane 2 terminals (if used) shall be electrically connected.
5. The corner shape (square, notch, radius, etc.) may vary at the manufacturer's option, from that shown on the drawing.
6. Chip carriers shall be constructed of a minimum of two ceramic layers.
7. Dimension "A" controls the overall package thickness. The maximum "A" dimension is package height before being solder dipped.
8. Dimensioning and tolerancing per ANSI Y14.5M-1982.
9. Controlling dimension: INCH.
10. Materials: Compliant to MIL-I-38535.

## *Ceramic Leadless Chip Carrier Packages (CLCC)*




**J28.A** MIL-STD-1835 CQCC1-N28 (C-4)
**28 PAD CERAMIC LEADLESS CHIP CARRIER PACKAGE**

| SYMBOL | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| A | 0.060 | 0.100 | 1.52 | 2.54 | 6, 7 |
| A1 | 0.050 | 0.088 | 1.27 | 2.23 | - |
| B | - | - | - | - | - |
| B1 | 0.022 | 0.028 | 0.56 | 0.71 | 2, 4 |
| B2 | 0.072 REF | | 1.83 REF | | - |
| B3 | 0.006 | 0.022 | 0.15 | 0.56 | - |
| D | 0.442 | 0.460 | 11.23 | 11.68 | - |
| D1 | 0.300 BSC | | 7.62 BSC | | - |
| D2 | 0.150 BSC | | 3.81 BSC | | - |
| D3 | - | 0.460 | - | 11.68 | 2 |
| E | 0.442 | 0.460 | 11.23 | 11.68 | - |
| E1 | 0.300 BSC | | 7.62 BSC | | - |
| E2 | 0.150 BSC | | 3.81 BSC | | - |
| E3 | - | 0.460 | - | 11.68 | 2 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| e1 | 0.015 | - | 0.38 | - | 2 |
| h | 0.040 REF | | 1.02 REF | | 5 |
| j | 0.020 REF | | 0.51 REF | | 5 |
| L | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L1 | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L2 | 0.075 | 0.095 | 1.90 | 2.41 | - |
| L3 | 0.003 | 0.015 | 0.08 | 0.038 | - |
| ND | 7 | | 7 | | 3 |
| NE | 7 | | 7 | | 3 |
| N | 28 | | 28 | | 3 |

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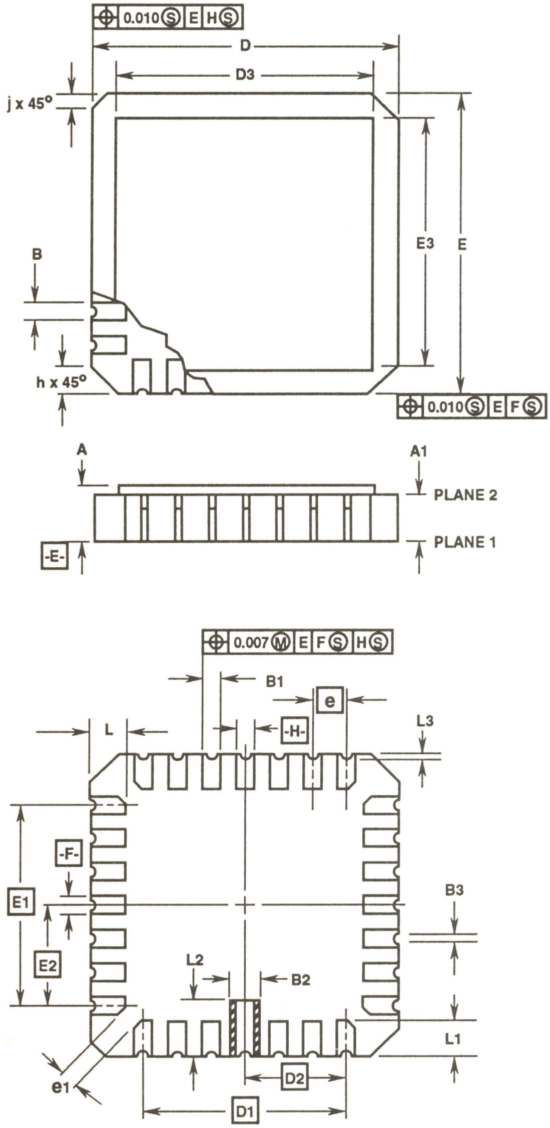
NOTES:

1. Metallized castellations shall be connected to plane 1 terminals and extend toward plane 2 across at least two layers of ceramic or completely across all of the ceramic layers to make electrical connection with the optional plane 2 terminals.
2. Unless otherwise specified, a minimum clearance of 0.015 inch (0.38mm) shall be maintained between all metallized features (e.g., lid, castellations, terminals, thermal pads, etc.)
3. Symbol "N" is the maximum number of terminals. Symbols "ND" and "NE" are the number of terminals along the sides of length "D" and "E", respectively.
4. The required plane 1 terminals and optional plane 2 terminals (if used) shall be electrically connected.
5. The corner shape (square, notch, radius, etc.) may vary at the manufacturer's option, from that shown on the drawing.
6. Chip carriers shall be constructed of a minimum of two ceramic layers.
7. Dimension "A" controls the overall package thickness. The maximum "A" dimension is package height before being solder dipped.
8. Dimensioning and tolerancing per ANSI Y14.5M-1982.
9. Controlling dimension: INCH.
10. Materials: Compliant to MIL-I-38535.

## *Ceramic Leadless Chip Carrier Packages (CLCC)*




**J44.A** MIL-STD-1835 CQCC1-N44 (C-5)
**44 PAD CERAMIC LEADLESS CHIP CARRIER PACKAGE**

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.064 | 0.120 | 1.63 | 3.05 | 6, 7 |
| A1 | 0.054 | 0.088 | 1.37 | 2.24 | - |
| B | 0.033 | 0.039 | 0.84 | 0.99 | 4 |
| B1 | 0.022 | 0.028 | 0.56 | 0.71 | 2, 4 |
| B2 | 0.072 REF | | 1.83 REF | | - |
| B3 | 0.006 | 0.022 | 0.15 | 0.56 | - |
| D | 0.640 | 0.662 | 16.26 | 16.81 | - |
| D1 | 0.500 BSC | | 12.70 BSC | | - |
| D2 | 0.250 BSC | | 6.35 BSC | | - |
| D3 | - | 0.662 | - | 16.81 | 2 |
| E | 0.640 | 0.662 | 16.26 | 16.81 | - |
| E1 | 0.500 BSC | | 12.70 BSC | | - |
| E2 | 0.250 BSC | | 6.35 BSC | | - |
| E3 | - | 0.662 | - | 16.81 | 2 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| e1 | 0.015 | - | 0.38 | - | 2 |
| h | 0.040 REF | | 1.02 REF | | 5 |
| j | 0.020 REF | | 0.51 REF | | 5 |
| L | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L1 | 0.045 | 0.055 | 1.14 | 1.40 | - |
| L2 | 0.075 | 0.095 | 1.90 | 2.41 | - |
| L3 | 0.003 | 0.015 | 0.08 | 0.38 | - |
| ND | 11 | | 11 | | 3 |
| NE | 11 | | 11 | | 3 |
| N | 44 | | 44 | | 3 |

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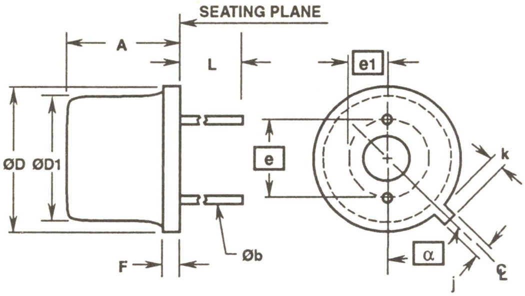
NOTES:

1. Metallized castellations shall be connected to plane 1 terminals and extend toward plane 2 across at least two layers of ceramic or completely across all of the ceramic layers to make electrical connection with the optional plane 2 terminals.
2. Unless otherwise specified, a minimum clearance of 0.015 inch (0.38mm) shall be maintained between all metallized features (e.g., lid, castellations, terminals, thermal pads, etc.)
3. Symbol "N" is the maximum number of terminals. Symbols "ND" and "NE" are the number of terminals along the sides of length "D" and "E", respectively.
4. The required plane 1 terminals and optional plane 2 terminals (if used) shall be electrically connected.
5. The corner shape (square, notch, radius, etc.) may vary at the manufacturer's option, from that shown on the drawing.
6. Chip carriers shall be constructed of a minimum of two ceramic layers.
7. Dimension "A" controls the overall package thickness. The maximum "A" dimension is package height before being solder dipped.
8. Dimensioning and tolerancing per ANSI Y14.5M-1982.
9. Controlling dimension: INCH.
10. Materials: Compliant to MIL-I-38535.

## Metal Can Packages (Can)




NOTES:

1. Measured from maximum diameter of the actual device.
2. Measured from tab centerline.
3. N is number of leads.
4. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
5. Controlling dimension: INCH.
6. Materials: Compliant to MIL-I-38535.

### T2.A

**2 LEAD METAL CAN PACKAGE**

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.130 | 0.150 | 3.30 | 3.81 | - |
| b | 0.016 | 0.019 | 0.41 | 0.48 | - |
| D | 0.205 | 0.22 | 5.21 | 5.59 | - |
| D1 | 0.180 | 0.190 | 4.57 | 4.83 | - |
| F | 0.010 | 0.025 | 0.25 | 0.64 | - |
| k | 0.033 | 0.046 | 0.84 | 1.17 | 1 |
| j | 0.033 | 0.045 | 0.84 | 1.14 | - |
| L | 0.500 | 0.560 | 12.70 | 14.22 | - |
| e | 0.100 BSC | | 2.54 BSC | | - |
| e1 | - | | - | | - |
| α | 45 | | 45 | | 2 |
| N | 2 | | 2 | | 3 |

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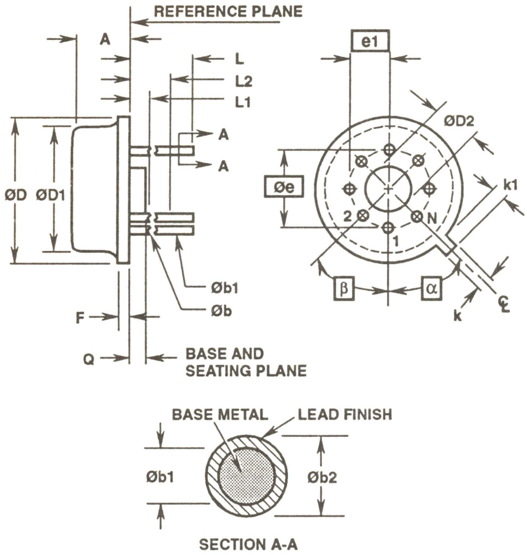
## Metal Can Packages (Can)




**T8.C** MIL-STD-1835 MACY1-X8 (A1)
8 LEAD METAL CAN PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.165 | 0.185 | 4.19 | 4.70 | - |
| Øb | 0.016 | 0.019 | 0.41 | 0.48 | 1 |
| Øb1 | 0.016 | 0.021 | 0.41 | 0.53 | 1 |
| Øb2 | 0.016 | 0.024 | 0.41 | 0.61 | - |
| ØD | 0.335 | 0.375 | 8.51 | 9.40 | - |
| ØD1 | 0.305 | 0.335 | 7.75 | 8.51 | - |
| ØD2 | 0.110 | 0.160 | 2.79 | 4.06 | - |
| e | 0.200 BSC | | 5.08 BSC | | - |
| e1 | 0.100 BSC | | 2.54 BSC | | - |
| F | - | 0.040 | - | 1.02 | - |
| k | 0.027 | 0.034 | 0.69 | 0.86 | - |
| k1 | 0.027 | 0.045 | 0.69 | 1.14 | 2 |
| L | 0.500 | 0.750 | 12.70 | 19.05 | 1 |
| L1 | - | 0.050 | - | 1.27 | 1 |
| L2 | 0.250 | - | 6.35 | - | 1 |
| Q | 0.010 | 0.045 | 0.25 | 1.14 | - |
| α | 45° BSC | | 45° BSC | | 3 |
| β | 45° BSC | | 45° BSC | | 3 |
| N | 8 | | 8 | | 4 |

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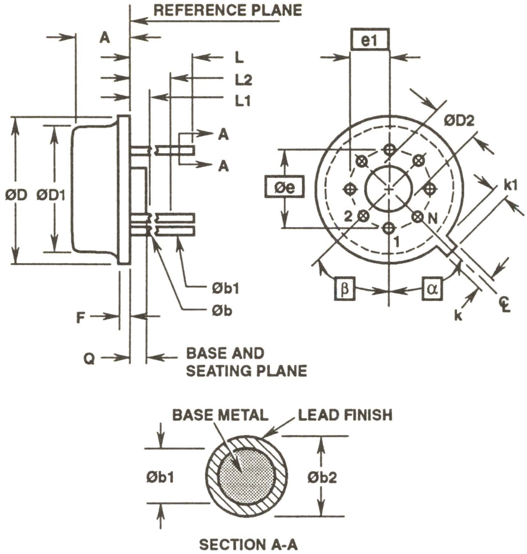
NOTES:

1. (All leads) Øb applies between L1 and L2. Øb1 applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
2. Measured from maximum diameter of the product.
3. α is the basic spacing from the centerline of the tab to terminal 1 and β is the basic spacing of each lead or lead position (N -1 places) from α, looking at the bottom of the package.
4. N is the maximum number of terminal positions.
5. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
6. Controlling dimension: INCH.
7. Materials: Compliant to MIL-I-38535.

## *Metal Can Packages (Can)*




NOTES:

1. (All leads) Øb applies between L1 and L2. Øb1 applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
2. Measured from maximum diameter of the product.
3. α is the basic spacing from the centerline of the tab to terminal 1 and β is the basic spacing of each lead or lead position (N -1 places) from α, looking at the bottom of the package.
4. N is the maximum number of terminal positions.
5. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
6. Controlling dimension: INCH.
7. Materials: Compliant to MIL-I-38535.

**T10.B** MIL-STD-1835 MACY1-X10 (A2)
10 LEAD METAL CAN PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.165 | 0.185 | 4.19 | 4.70 | - |
| Øb | 0.016 | 0.019 | 0.41 | 0.48 | 1 |
| Øb1 | 0.016 | 0.021 | 0.41 | 0.53 | 1 |
| Øb2 | 0.016 | 0.024 | 0.41 | 0.61 | - |
| ØD | 0.335 | 0.375 | 8.51 | 9.52 | - |
| ØD1 | 0.305 | 0.335 | 7.75 | 8.51 | - |
| ØD2 | 0.110 | 0.160 | 2.79 | 4.06 | - |
| e | 0.230 BSC | | 5.84 BSC | | - |
| e1 | 0.115 BSC | | 2.92 BSC | | - |
| F | - | 0.040 | - | 1.02 | - |
| k | 0.027 | 0.034 | 0.69 | 0.86 | - |
| k1 | 0.027 | 0.045 | 0.69 | 1.14 | 2 |
| L | 0.500 | 0.750 | 12.70 | 19.05 | 1 |
| L1 | - | 0.050 | - | 1.27 | 1 |
| L2 | 0.250 | - | 6.35 | - | 1 |
| Q | 0.010 | 0.045 | 0.25 | 1.14 | - |
| α | 36° BSC | | 36° BSC | | 3 |
| β | 36° BSC | | 36° BSC | | 3 |
| N | 10 | | 10 | | 4 |

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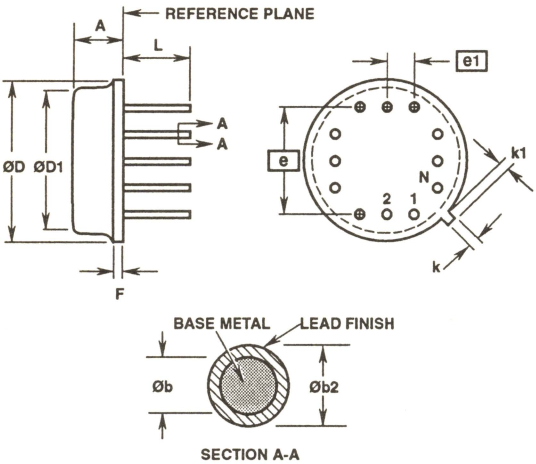
## Metal Can Packages (Can)




### T12.C

12 LEAD METAL CAN PACKAGE

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.130 | 0.150 | 3.30 | 3.81 | - |
| Øb | 0.016 | 0.019 | 0.41 | 0.48 | - |
| Øb2 | 0.016 | 0.021 | 0.41 | 0.53 | - |
| ØD | 0.585 | 0.615 | 14.86 | 15.62 | - |
| ØD1 | 0.540 | 0.560 | 13.72 | 14.22 | - |
| e | 0.400 BSC | | 10.16 BSC | | - |
| e1 | 0.100 BSC | | 2.54 BSC | | - |
| F | 0.020 | 0.040 | 0.51 | 1.02 | - |
| k | 0.027 | 0.034 | 0.69 | 0.86 | - |
| k1 | 0.027 | 0.045 | 0.69 | 1.14 | 2 |
| L | 0.500 | 0.560 | 12.70 | 14.22 | - |
| N | 12 | | 12 | | 3 |

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NOTES:

1. The reference, base, and seating planes are the same for this variation.
2. Measured from maximum diameter of the product.
3. N is the maximum number of terminal positions.
4. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
5. Controlling dimension: INCH.
6. Materials: Compliant to MIL-I-38535.

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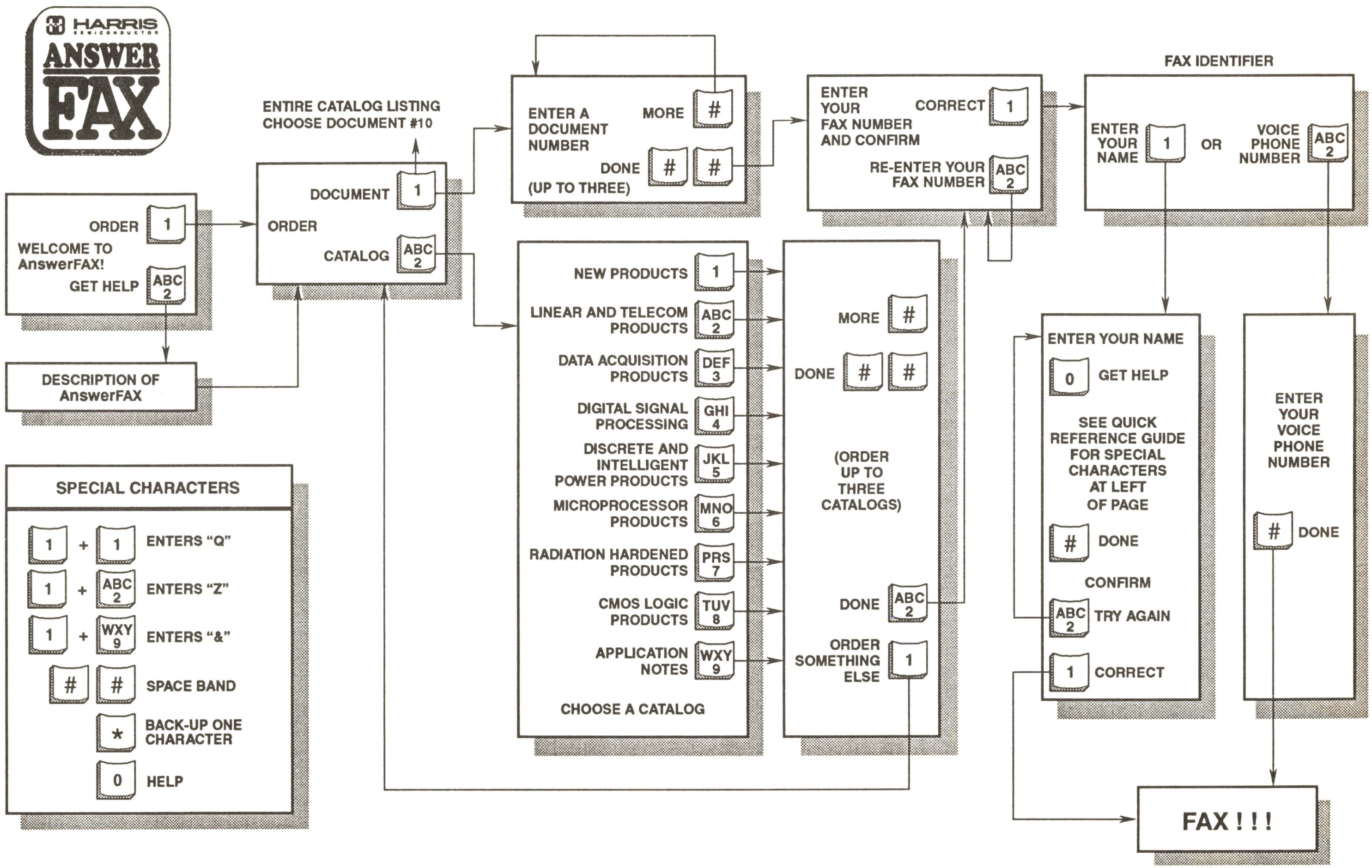

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| DB220.1 | **BIPOLAR POWER TRANSISTORS** (1992: 592pp) Technical information on over 750 power transistors for use in a wide range of consumer, industrial and military applications. |
| DB235B | **RADIATION HARDENED** (1993: 2,232pp) Harris technologies used include dielectric isolation (DI), Silicon-on-Sapphire (SOS), and Silicon-on-Insulator (SOI). The Harris radiation-hardened products include the CD4000, HCS/HCTS and ACS/ACTS logic families, SRAMs, PROMs, op amps, analog multiplexers, the 80C85/80C86 microprocessor family, analog switches, gate arrays, standard cells and custom devices. |
| DB303 | **MICROPROCESSOR PRODUCTS** (1992: 1,156pp) For commercial and military applications. Product specifications on CMOS microprocessors, peripherals, data communications, and memory ICs. |
| DB309 | **MCT/IGBT/DIODES** (1994: 528pp) This data book fully describes Harris Semiconductor's line of MOS Controlled Thyristors, Insulated Gate Bipolar Transistors (IGBTs) and Power Diodes/Rectifiers. |
| Analog Military | **ANALOG MILITARY** (1989: 1,264pp) This data book describes Harris' military line of Linear, Data Acquisition, and Telecommunications circuits. |
| DB312 | **ANALOG MILITARY DATA BOOK SUPPLEMENT** (1994: 432pp) The 1994 Military Data Book Supplement, combined with the 1989 Analog Military Product Data Book, contain detailed technical information on the extensive line of Harris Semiconductor Linear and Data Acquisition products for Military (MIL-STD-883, DESC SMD and JAN) applications and supersedes all previously published Linear and Data Acquisition Military data books. For applications requiring Radiation Hardened products, please refer to the 1993 Harris Radiation Hardened Product Data Book (document #DB235B) |
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|---|---|---|
| 27007 | BR007 | Complete Listing of Harris Sales Offices, Representatives and Authorized Distributors World Wide (7 pages) |
| 27026 | BR026 | Linear and Data Acquisition Product Cross Reference (26 pages) |
| LINEAR DATA SHEETS | | |
| 796 | CA124, CA224, CA324, LM324*, LM2902* | Quad Operational Amplifiers for Commercial, Industrial and Military Applications (7 pages) |
| 795 | CA139, CA239, CA339, LM339, LM2901, LM3302 | Quad Voltage Comparators for Industrial, Commercial and Military Applications (5 pages) |
| 1019 | CA158, CA258, CA358, CA2904, LM358*, LM2904* | Dual Operational Amplifiers for Commercial, Industrial and Military Applications (11 pages) |
| 834 | CA555, LM555 | Timers for Timing Delays and Oscillator Applications in Commercial, Industrial and Military Equipment (6 pages) |
| 531 | CA741, CA1458, CA1558, LM741*, LM1458*, LM1558* | High Gain Single and Dual Operational Amplifiers for Military, Industrial and Commercial Applications (6 pages) |
| 981 | CA1391, CA1394 | TV Horizontal Processors (4 pages) |
| 338 | CA3018 | General Purpose Transistor Arrays (6 pages) |
| 339 | CA3020 | Multipurpose Wide-Band Power Amps Military, Industrial and Commercial Equipment at Frequency Up to 8MHz (9 pages) |
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| 532 | CA3146, CA3183 | High-Voltage Transistor Arrays (10 pages) |
| 976 | CA3160 | BiMOS Operational Amplifiers with MOSFET Input/CMOS Output (17 pages) |

*Technical Data on LM Branded Types is Identical to the Corresponding CA Branded Types

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| 1046 | CA3189 | FM IF System (7 pages) |
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| 1345 | CA3227, CA3246 | High-Frequency N-P-N Transistor Arrays for Low Power Applications at Frequencies Up to 1.5GHz (5 pages) |
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| 1050 | CA3240 | Dual BiMOS Operational Amplifier with MOSFET Input/Bipolar Output (16 pages) |
| 1769 | CA3256 | BiMOS Analog Video Switch and Amplifier (12 pages) |
| 1266 | CA3260 | BiMOS Operational Amplifier with MOSFET Input/CMOS Output (4 pages) |
| 1174 | CA3280 | Dual Variable Operational Amplifier (11 pages) |
| 1049 | CA3290 | BiMOS Dual Voltage Comparator with MOSFET Input, Bipolar Output (8 pages) |
| 1320 | CA3420 | Low Supply Voltage, Low Input Current BiMOS Operational Amplifiers (5 pages) |
| 1318 | CA3440 | Nanopower BiMOS Operational Amplifier (6 pages) |
| 1732 | CA3450 | Video Line Driver, High Speed Operational Amplifier (8 pages) |
| 1923 | CA5130 | BiMOS Microprocessor Operational Amplifier with MOSFET Input/CMOS Output (17 pages) |
| 1924 | CA5160 | BiMOS Microprocessor Operational Amplifiers with MOSFET Input/ CMOS Output (20 pages) |
| 1929 | CA5260 | BiMOS Microprocessor Operational Amplifiers with MOSFET Input/ CMOS Output (5 pages) |
| 1925 | CA5420 | Low Supply Voltage, Low Input Current BiMOS Operational Amplifier (7 pages) |
| 1946 | CA5470 | Quad Microprocessor BiMOS-E Operational Amplifiers with MOSFET Input/Bipolar Output (5 pages) |

| AnswerFAX DOCUMENT NUMBER | PART NUMBER | DESCRIPTION |
|---|---|---|
| 1076 | CD22100 | CMOS 4 x 4 Crosspoint Switch and Control Memory High-Voltage Type (20V Rating) (9 pages) |
| 2871 | CD22101, CD22102 | CMOS 4 x 4 x 2 Crosspoint Switch with Control Memory (12 pages) |
| 1310 | CD22103A | CMOS HDB3 (High Density Bipolar 3) Transcoder for 2.048/8.448 Mb/s Transmission Applications (6 pages) |
| 1695 | CD22202, CD22203 | 5V Low Power DTMF Receiver (6 pages) |
| 1696 | CD22204 | 5V Low Power Subscriber DTMF Receiver (5 pages) |
| 1368 | CD22301 | Monolithic PCM Repeater (5 pages) |
| 2491 | CD22M3493 | 12 x 8 x 1 BiMOS-E Crosspoint Switch (5 pages) |
| 3587 | CD22M3493 ER2536 | 12 x 8 x 1 BiMOS-E Crosspoint Switch (6 pages) |
| 2793 | CD22M3494 | 16 x 8 x 1 BiMOS-E Crosspoint Switch (6 pages) |
| 1682 | CD22354A, CD22357A | CMOS Single-Chip, Full-Feature PCM CODEC (10 pages) |
| 1686 | CD22402 | Sync Generator for TV Applications and Video Processing Systems (10 pages) |
| 1257 | CD22859 | Monolithic Silicon COS/MOS Dual-Tone Multifrequency Tone Generator (5 pages) |
| 1719 | CD74HC22106, CD74HCT22106 | QMOS 8 x 8 x 1 Crosspoint Switch with Memory Control (9 pages) |
| 2891 | HA-2400, HA-2404, HA-2405 | PRAM Four Channel Programmable Amplifiers (6 pages) |
| 3926 | HA-2400/883 | PRAM Four Channel Programmable Operational Amplifier (11 pages) |
| 2892 | HA-2406 | Digitally Selectable Four Channel Operational Amplifier (6 pages) |
| 2856 | HA-2420, HA-2425 | Fast Sample and Hold Amplifiers (9 pages) |
| 2490 | HA-2444 | Selectable, Four Channel Video Operational Amplifier (3 pages) |
| 3608 | HA-2444/883 | Selectable, Four Channel Video Operational Amplifier (8 pages) |
| 2890 | HA-2500, HA-2502, HA-2505 | Precision High Slew Rate Operational Amplifiers (6 pages) |
| 3734 | HA-2500/883, HA-2502/883 | Precision High Slew Rate Operational Amplifiers (10 pages) |

| AnswerFAX DOCUMENT NUMBER | PART NUMBER | DESCRIPTION |
|---|---|---|
| 2893 | HA-2510, HA-2512, HA-2515 | High Slew Rate Operational Amplifiers (5 pages) |
| 3697 | HA-2510/883, HA-2512/883 | High Slew Rate Operational Amplifiers (11 pages) |
| 2894 | HA-2520, HA-2522, HA-2525 | Uncompensated High Slew Rate Operational Amplifiers (7 pages) |
| 3735 | HA-2520/883, HA-2522/883 | Uncompensated, High Slew Rate Operational Amplifiers (11 pages) |
| 2895 | HA-2529 | Uncompensated, High Slew Rate High Output Current, Operational Amplifier (7 pages) |
| 3736 | HA-2529/883 | Uncompensated, High Slew Rate High Output Current, Operational Amplifier (12 pages) |
| 2896 | HA-2539 | Very High Slew Rate Wideband Operational Amplifier (7 pages) |
| 3927 | HA-2539/883 | Very High Slew Rate Wideband Operational Amplifier (11 pages) |
| 2897 | HA-2540 | Wideband, Fast Settling Operational Amplifier (8 pages) |
| 2898 | HA-2541 | Wideband, Fast Settling, Unity Gain Stable, Operational Amplifier (8 pages) |
| 3698 | HA-2541/883 | Wideband, Fast Settling, Unity Gain Stable, Operational Amplifier (11 pages) |
| 2899 | HA-2542 | Wideband, High Slew Rate, High Output Current Operational Amplifier (10 pages) |
| 3928 | HA-2542/883 | Wideband, High Slew Rate, High Output Current, Operational Amplifier (12 pages) |
| 2900 | HA-2544 | Video Operational Amplifier (10 pages) |
| 3699 | HA-2544/883 | Video Operational Amplifier (13 pages) |
| 2861 | HA-2546 | Wideband Two Quadrant Analog Multiplier (13 pages) |
| 2444 | HA-2546/883 | Wideband Two Quadrant Analog Multiplier (Voltage Output) (19 page) |
| 2444 | HA-2546/883 | Wideband Two Quadrant Analog Multiplier (19 pages) |
| 2862 | HA-2547 | Wideband Two Quadrant Analog Multiplier (8 pages) |

| AnswerFAX DOCUMENT NUMBER | PART NUMBER | DESCRIPTION |
|---|---|---|
| 2901 | HA-2548 | Precision, High Slew Rate, Wideband Operational Amplifier (10 pages) |
| 2472 | HA-2548/883 | Precision, High Slew Rate, Wideband Operational Amplifier (14 pages) |
| 2477 | HA-2556 | Wideband Four Quadrant Voltage Output Analog Multiplier (18 pages) |
| 3619 | HA-2556/883 | Wideband Four Quadrant Analog Multiplier (Voltage Output) (20 pages) |
| 2478 | HA-2557 | Wideband Four Quadrant Current Output Analog Multiplier (13 pages) |
| 3638 | HA-2557/883 | Wideband Four Quadrant Analog Multiplier (Current Output) (14 pages) |
| 2902 | HA-2600, HA-2602, HA-2605 | Wideband, High Impedance Operational Amplifiers (8 pages) |
| 3700 | HA-2600/883, HA-2602/883 | Wideband, High Impedance Operational Amplifiers (11 pages) |
| 2903 | HA-2620, HA-2622, HA-2625 | Very Wideband, Uncompensated Operational Amplifiers (7 pages) |
| 3701 | HA-2620/883, HA-2622/883 | Very Wideband, High Input Impedance Uncompensated Operational Amplifiers (11 pages) |
| 2904 | HA-2640, HA-2645 | High Voltage Operational Amplifiers (6 pages) |
| 3702 | HA-2640/883 | High Voltage Operational Amplifier (11 pages) |
| 3391 | HA-2705 | Low Power, High Performance Operational Amplifier (3 pages) |
| 2841 | HA-2839 | Very High Slew Rate Wideband Operational Amplifier (8 pages) |
| 3593 | HA-2839/883 | Very High Slew Rate, Wideband Operational Amplifier (13 pages) |
| 2842 | HA-2840 | Very High Slew Rate Wideband Operational Amplifier (8 pages) |
| 3594 | HA-2840/883 | Very High Slew Rate, Wideband Operational Amplifier (13 pages) |
| 2843 | HA-2841 | Wideband, Fast Settling, Unity Gain Stable, Video Operational Amplifier (9 pages) |
| 3621 | HA-2841/883 | Wideband, Fast Settling, Unity Gain Stable, Video Operational Amplifier (14 pages) |
| 2766 | HA-2842 | Wideband, High Slew Rate, High Output Current, Video Operational Amplifier (9 pages) |

| AnswerFAX DOCUMENT NUMBER | PART NUMBER | DESCRIPTION |
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| 3622 | HA-2842/883 | Wideband, High Slew Rate, High Output Current, Video Operational Amplifier (14 pages) |
| 2844 | HA-2850 | Low Power, High Slew Rate Wideband Operational Amplifier (8 pages) |
| 3595 | HA-2850/883 | Low Power, High Slew Rate, Wideband Operational Amplifier (13 pages) |
| 3680 | HA4201 | Wideband, 1 x 1 Video Crosspoint Switch with Talley Output (4 pages) |
| 3679 | HA4314 | Wideband, 4 x 1 Video Crosspoint Switch (4 pages) |
| 3678 | HA4404 | Wideband, 4 x 1 Video Crosspoint Switch with Talley Outputs (4 pages) |
| 2922 | HA-4741 | Quad Operational Amplifier (6 pages) |
| 3704 | HA-4741/883 | Quad Operational Amplifier (11 pages) |
| 2855 | HA-4900, HA-4902, HA-4905 | Precision Quad Comparator (8 pages) |
| 3929 | HA-4902/883 | Precision Quad Comparator (10 pages) |
| 2921 | HA-5002 | Monolithic, Wideband, High Slew Rate, High Output Current Buffer (8 pages) |
| 3705 | HA-5002/883 | Monolithic, Wideband, High Slew Rate, High Output Current Buffer (15 pages) |
| 2923 | HA-5004 | 100MHz Current Feedback Amplifier (9 pages) |
| 3706 | HA-5004/883 | 100MHz Current Feedback Amplifier (13 pages) |
| 3654 | HA5013 | Triple 125MHz Video Amplifier (16 pages) |
| 2845 | HA-5020 | 100MHz Current Feedback Video Amplifier (11 pages) |
| 3541 | HA-5020/883 | 100MHz Current Feedback Video Amplifier with Disable (19 pages) |
| 3392 | HA5022 | Dual, 125MHz Video Current Feedback Amplifier with Disable (18 pages) |
| 3729 | HA5022/883 | Dual 100MHz Video Current Feedback Amplifier with Disable (5 pages) |
| 3393 | HA5023 | Quad 125MHz Video Current Feedback Amplifier with Disable (16 pages) |

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| 3730 | HA5023/883 | Dual 100MHz Video Current Feedback Amplifier (4 pages) |
| 3550 | HA5024 | Quad 125MHz Video Current Feedback Amplifier with Disable (18 pages) |
| 3591 | HA5025 | Quad 125MHz Video Current Feedback Amplifier (16 pages) |
| 2924 | HA-5033 | Video Buffer (10 pages) |
| 3930 | HA-5033/883 | Video Buffer (12 pages) |
| 2905 | HA-5101, HA-511 | Low Noise, High Performance Operational Amplifiers (10 pages) |
| 3931 | HA-5101/883 | Low Noise, High Performance Operational Amplifier (13 pages) |
| 2925 | HA-5102, HA-5104, HA-5112, HA-5114 | Low Noise, High Performance Operational Amplifiers (10 pages) |
| 3709 | HA-5102/883 | Dual, Low Noise, High Performance Operational Amplifier (13 pages) |
| 3710 | HA5104/88 | Low Noise, High Performance, Quad Operational Amplifier (13 pages) |
| 3932 | HA-5111/883 | Low Noise, High Performance Uncompensated Operational Amplifier (13 pages) |
| 3711 | HA-5112/883 | Dual, Low Noise, High Performance Uncompensated Operational Amplifier (13 pages) |
| 3712 | HA-5114/883 | Quad, Low Noise, High Performance Uncompensated Operational Amplifier (13 pages) |
| 2906 | HA-5127 | Ultra-Low Noise Precision Operational Amplifier (9 pages) |
| 3751 | HA-5127/883 | Ultra Low Noise, Precision Operational Amplifier (13 pages) |
| 2907 | HA-5130, HA-5135 | Precision Operational Amplifiers (8 pages) |
| 2926 | HA-5134 | Precision Quad Operational Amplifier (8 pages) |
| 3713 | HA-5134/883 | Precision Quad Operational Amplifier (13 pages) |
| 3731 | HA-5135/883 | Precision Operational Amplifier (13 pages) |
| 2908 | HA-5137 | Ultra-Low Noise Precision Wideband Operational Amplifier (8 pages) |
| 3714 | HA-5137/883 | Ultra Low Noise, Precision Wideband Operational Amplifier (13 pages) |

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| 2909 | HA-5142, HA-5144 | Dual/Quad Ultra-Low Power Operational Amplifiers (7 pages) |
| 3732 | HA-5142/883 | Dual, Ultra Low Power Operational Amplifier (12 pages) |
| 3934 | HA-5144/883 | Quad, Ultra-Low Power Operational Amplifier (12 pages) |
| 2910 | HA-5147 | Ultra-Low Noise Precision High Slew Rate Wideband Operational Amplifier (8 pages) |
| 3715 | HA-5147/883 | Ultra Low Noise, Precision, High Slew Rate Wideband Operational Amplifier (13 pages) |
| 2911 | HA-5160, HA-5162 | Wideband, JFET Input High Slew Rate, Uncompensated, Operational Amplifiers (8 pages) |
| 2912 | HA-5170 | Precision JFET Input Operational Amplifier (8 pages) |
| 2913 | HA-5177 | Ultra-Low Offset Voltage Operational Amplifier (10 pages) |
| 3733 | HA-5177/883 | Ultra Low Offset Voltage Operational Amplifier (14 pages) |
| 2914 | HA-5190, HA-5195 | Wideband, Fast Settling Operational Amplifiers (8 pages) |
| 2915 | HA-5221, HA-5222 | Low Noise, Wideband Precision Operational Amplifier (11 pages) |
| 3716 | HA-5221/883 | Low Noise, Wideband, Precision Operational Amplifier (12 pages) |
| 3717 | HA-5222/883 | Dual, Low Noise, Wideband, Precision Operational Amplifier (15 pages) |
| 2851 | HA5232, HA5234 | Precision Dual and Quad Operational Amplifiers (5 pages) |
| 2857 | HA-5320 | High Speed Precision Monolithic Sample and Hold Amplifier (10 pages) |
| 2927 | HA-5320/883 | High Speed Precision Sample and Hold Amplifier (12 pages) |
| 2858 | HA-5330 | Very High Speed Precision Monolithic Sample and Hold Amplifier (4 pages) |
| 3935 | HA-5330/883 | Very High Speed Precision Monolithic Sample and Hold Amplifier (9 pages) |
| 2859 | HA-5340 | High Speed, Low Distortion, Precision Monolithic Sample and Hold Amplifier (8 pages) |
| 2452 | HA-5340/883 | High Speed, Low Distortion, Precision Monolithic Sample and Hold Amplifier (12 pages) |

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| 2452 | HA-5340/883 | High Speed, Low Distortion, Precision Monolithic Sample and Hold Amplifier (12 pages) |
| 3690 | HA5351 | Fast Acquisition Sample and Hold Amplifier (7 pages) |
| 3727 | HA-5351/883 | Fast Acquisition, Low Power Sample and Hold Amplifier (1 page) |
| 3394 | HA5352 | Fast Acquisition Dual Sample and Hold Amplifier (7 pages) |
| 3728 | HA-5352/883 | Fast Acquisition Dual Sample and Hold Amplifier (1 page) |
| 3389 | HA7210 | Low Power Crystal Oscillator (15 pages) |
| 2884 | HC-5502B | SLIC Subscriber Line Interface Circuit (9 pages) |
| 3588 | HC-5504ALC | SLIC Subscriber Line Interface Circuit (9 pages) |
| 2886 | HC-5504B | SLIC Subscriber Line Interface Circuit (8 pages) |
| 2443 | HC-5504DLC | SLIC Subscriber Line Interface Circuit (8 pages) |
| 3567 | HC-5509A1 | SLIC Subscriber Line Interface Circuit (10 pages) |
| 2799 | HC-5509B | SLIC Subscriber Line Interface Circuit (10 pages) |
| 2798 | HC-5524 | SLIC Subscriber Line Interface Circuit (9 pages) |
| 2887 | HC-5560 | PCM Transcoder (9 pages) |
| 2888 | HC-55536 | Continuous Variable Slope Delta-Demodulator (CVSD) (3 pages) |
| 2889 | HC-55564 | Continuously Variable Slope Delta-Modulator (CVSD) (6 pages) |
| 3738 | HC-55564/883 | Continuously Variable Slope Delta-Modulator (CVSD) (14 pages) |
| 2916 | HFA-0001 | Ultra High Slew Rate Operational Amplifier (10 pages) |
| 2917 | HFA-0002 | Low Noise Wideband Operational Amplifier (9 pages) |
| 2749 | HFA-0003, HFA-0003L | Ultra High Speed Comparator (4 pages) |
| 2918 | HFA-0005 | High Slew Rate Operational Amplifier (10 pages) |
| 2945 | HFA1100, HFA1120 | Ultra High-Speed, Current Feedback Amplifiers (12 pages) |
| 3615 | HFA1100/883 | 850MHz Current Feedback Amplifier (16 pages) |

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| 3597 | HFA1102 | Ultra High-Speed, Current Feedback Amplifier with Compensation Pin (8 pages) |
| 3547 | HFA1102Y | Ultra High-Speed Current Feedback Amplifier with Compensation Pin (4 pages) |
| 3395 | HFA1105, HFA1145 | High-Speed, Low Power, Current Feedback Operational Amplifiers (7 pages) |
| 2944 | HFA1110 | 750MHz Low Distortion Unity Gain, Closed Loop Buffer (9 pages) |
| 3620 | HFA1110/883 | 750MHz, Low Distortion Unity Gain, Closed Loop Buffer (15 pages) |
| 2992 | HFA1112 | Ultra High-Speed Programmable Gain Buffer Amplifier (15 pages) |
| 3610 | HFA1112/883 | Ultra High Speed Programmable Gain Buffer Amplifier (18 pages) |
| 1342 | HFA1113 | Output Limiting, Ultra High Speed, Programmable Gain, Buffer Amplifier (19 pages) |
| 3618 | HFA1113/883 | Output Limiting, Ultra High Speed Programmable Gain, Buffer Amplifier (22 pages) |
| 3151 | HFA1114 | Ultra High-Speed Programmable Gain Buffer Amplifier (7 pages) |
| 3606 | HFA1115 | High-Speed, Low Power, Output Limiting, Closed Loop Buffer Amplifier (9 pages) |
| 3724 | HFA1115/883 | High Speed, Low Power, Output Limiting Closed Loop Buffer Amplifier (5 pages) |
| 3617 | HFA1120/883 | 850MHz Current Feedback Amplifier with Offset Adjust (17 pages) |
| 3369 | HFA1130 | Output Clamping, Ultra High-Speed Current Feedback Amplifier (11 pages) |
| 3625 | HFA1130/883 | Output Clamping, 850MHz Current Feedback Amplifier (19 pages) |
| 3653 | HFA1135 | High-Speed, Low Power, Video Operational Amplifier with Output Limiting (7 pages) |
| 3725 | HFA1135/883 | High Speed, Low Power Current Feedback Amplifier with Programmable Output Limiting (5 pages) |
| 3726 | HFA1145/883 | High Speed, Low Power, Current Feedback Video Operational Amplifier with Output Disable (5 pages) |
| 3605 | HFA1205 | Dual High-Speed, Low Power, Video Operational Amplifiers (8 pages) |
| 3607 | HFA1212, HFA1412 | Dual/Quad High-Speed, Low Power Closed Loop Buffer Amplifiers (5 pages) |
| 3742 | HFA1212/883 | Dual, High Speed, Low Power, Video Closed Loop Buffer (5 pages) |
| 3682 | HFA1245 | Dual, High-Speed, Low Power, Video Operational Amplifier with Disable (8 pages) |
| 3743 | HFA1245/883 | Dual, High Speed, Low Power, Video Operational Amplifier with Output Disable (6 pages) |
| 3604 | HFA1405 | Quad High-Speed, Low Power, Current Feedback Operational Amplifier (7 pages) |
| 3744 | HFA1412/883 | Quad, High Speed, Low Power, Video Closed Loop Buffer (4 pages) |
| 3076 | HFA3046, HFA3096, HFA3127, HFA3128 | Ultra High Frequency Transistor Array (6 pages) |
| 3663 | HFA3101 | Gilbert Cell UHF Transistor Array (13 pages) |
| 3635 | HFA3102 | Dual Long-Tailed Pair Transistor Array (7 pages) |
| 3655 | HFA3600 | Low-Noise Amplifier/Mixer (14 pages) |
| 2943 | HFA5250 | Ultra High-Speed, Monolithic Pin Driver (4 pages) |
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| 2919 | ICL7611, ICL7612 | ICL76XX Series Low Power CMOS Operational Amplifiers (12 pages) |
| 3403 | ICL7621, ICL7641, ICL7642 | ICL76XX Series Low Power CMOS Operational Amplifiers (12 pages) |
| 2920 | ICL7650S | Super Chopper-Stabilized Operational Amplifier (12 pages) |
| 2863 | ICL8013 | Four Quadrant Analog Multiplier (8 pages) |
| 2864 | ICL8038 | Precision Waveform Generator/ Voltage Controlled Oscillator (10 pages) |
| 2865 | ICL8048, ICL8049 | Log/Antilog Amplifiers (10 pages) |
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| **9013** | AN013 | Everything You Always Wanted to Know About the ICL8038 (4 pages) |
| **9040** | AN040 | Using the ICL8013 Four Quadrant Analog Multiplier (6 pages) |
| **9053** | AN053 | The ICL7650 A New Era in Glitch-Free Chopper Stabilized Amplifiers (19 pages) |
| **9509** | AN509 | A Simple Comparator Using the HA-2620 (1 page) |
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| **9515** | AN515 | Operational Amplifier Stability: Input Capacitance Considerations (2 pages) |
| **9519** | AN519 | Operational Amplifier Noise Prediction (4 pages) |
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| **9543** | AN543 | New High Speed Switch Offers Sub-50ns Switching Times (7 pages) |
| **9544** | AN544 | Micropower Op Amp Family HA-5141/42/44 and HA-5151/52/54 (6 pages) |
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| **95290** | AN5290 | Integrated-Circuit Operational Amplifiers (20 pages) |
| **96048** | AN6048 | Some Applications of A Programmable Power Switch/Amp (12 pages) |
| **96077** | AN6077 | An IC Operational Transconductance-Amplifier (OTA) With Power Capability (12 pages) |
| **96182** | AN6182 | Features and Applications of Integrated Circuit Zero-Voltage Switches (CA3058, CA3059 and CA3079) (31 pages) |
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| 99202 | AN9202 | Using the HFA1100, HFA1130 Evaluation Fixture (4 pages) |
| 99314 | AN9314 | Harris UHF Pin Drivers (4 pages) |
| 99315 | AN9315 | RF Amplifier Design Using HFA3046/3096/3127/3128 Transistor Arrays (4 pages) |
| 99317 | AN9317 | Micropower Clock Oscillator and Op Amps Provide System Control for Battery Operated Circuits (2 pages) |
| 99327 | AN9327 | HC-5509A1 Ring Trip Component Selection (9 pages) |
| 99334 | AN9334 | Improving Start-Up Time at 32kHz for the HA7210 Low Power Crystal Oscillator (2 pages) |
| 660001 | MM0001 | HFA-0001 Spice Operational Amplifier Macro-Model (4 pages) |
| 660002 | MM0002 | HFA-0002 Spice Operational Amplifier Macro-Model (4 pages) |
| 660005 | MM0005 | HFA-0005 Spice Operational Amplifier Marco-Model (4 pages) |
| 662500 | MM2500 | HA2500/02 Spice Operational Amplifier Macro-Model (5 pages) |
| 662510 | MM2510 | HA-2510/12 Spice Operational Amplifier Macro-Model (4 pages) |
| 662520 | MM2520 | HA-2520/22 Spice Operational Amplifier Macro-Model (4 pages) |
| 662539 | MM2539 | HA-2539 Spice Operational Amplifier Macro-Model (4 pages) |
| 662540 | MM2540 | HA-2540 Spice Operational Amplifier Macro-Model (4 pages) |
| 662541 | MM2541 | HA-2541 Spice Operational Amplifier Macro-Model (5 pages) |
| 662542 | MM2542 | HA-2542 Spice Operational Amplifier Macro-Model (5 pages) |
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| 662839 | MM2839 | HA-2839 Spice Operational Amplifier Macro-Model (4 pages) |
| 662840 | MM2840 | HA-2840 Spice Operational Amplifier Macro-Model (4 pages) |
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| 662850 | MM2850 | HA-2850 Spice Operational Amplifier Macro-Model (4 pages) |
| 663046 | MM3046 | HFA3046/3096/3127/3128 Transistor Array Spice Models (4 pages) |
| 665002 | MM5002 | HA-5002 Spice Buffer Amplifier Macro-Model (4 pages) |
| 665004 | MM5004 | HA-5004 Spice Current Feedback Amplifier Macro-Model (4 pages) |
| 665020 | MM5020 | HA-5020 Spice Current Feedback Operational Amplifier Macro-Model (4 pages) |
| 665033 | MM5033 | HA-5033 Spice Buffer Amplifier Macro-Model (4 pages) |
| 665101 | MM5101 | HA-5101 Spice Operational Amplifier Macro-Model (5 pages) |
| 665102 | MM5102 | HA-5102 Spice Operational Amplifier Macro-Model (5 pages) |
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| 665190 | MM5190 | HA-5190 Spice Operational Amplifier Macro-Model (4 pages) |
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| **27007** | BR007 | Complete Listing of Harris Sales Offices, Representatives and Authorized Distributors World Wide (7 pages) |
| **27026** | BR026 | Linear and Data Acquisition Product Cross Reference (26 pages) |
| **7051** | | High Speed Data Converters A/D, D/A Cross Reference (1 page) |
| **DATA ACQUISITION DATA SHEETS** | | |
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| **3102** | CA3306 | CMOS Video Speed 6-Bit Flash A/D Converter (1 page) |
| **3103** | CA3318C | CMOS Video Speed 8-Bit Flash A/D Converter (1 page) |
| **1850** | CA3338, CA3338A | CMOS Video Speed 8-Bit R-2R D/A Converter (7 pages) |
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| **3283** | DG408, DG409 | Single 8-Channel/Differential 4-Channel CMOS Analog Multiplexers (17 pages) |
| **3688** | DG408/883, DG409/883 | Single 8-Channel/Differential 4-Channel CMOS Analog Multiplexers (14 pages) |
| **3282** | DG411, DG412, DG413 | Monolithic Quad SPST CMOS Analog Switches (11 pages) |
| **3681** | DG411/883, DG412/883, DG413/883 | Monolithic Quad SPST CMOS Analog Switches (10 pages) |
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| **3708** | DG458/883, DG459/883 | Single 8-Channel/Differential 4-Channel Fault Protected Analog Multiplexers (1 page) |
| **2494** | HBC2500 | 3µm BiMOS-E Analog/Digital Library (8 pages) |
| **3123** | HI-201HS | High Speed Quad SPST CMOS Analog Switch (1 page) |
| **3124** | HI-222 | High Frequency/Video Switch (8 pages) |
| **3148** | HI-524 | 4 Channel Wideband and Video Multiplexer (1 page) |
| **3580** | HI-562A | 12-Bit High Speed Monolithic D/A Converter (6 pages) |
| **3109** | HI-565A | High Speed Monolithic D/A Converter with Reference (1 page) |
| **3096** | HI-574A | Fast, Complete 12-Bit A/D Converter with Microprocessor Interface (15 pages) |
| **3634** | HI5813 | CMOS 3.3V, 25µs 12-Bit Sampling A/D Converter with Internal Track and Hold (12 pages) |
| **3664** | HI5816 | CMOS 12-Bit Sampling A/D Converter with Serial Data Output and Internal Track and Hold (16 pages) |
| **3097** | HI-674A | 12µs, Complete 12-Bit A/D Converter with Microprocessor Interface (11 pages) |
| **3098** | HI-774 | 8µs, Complete 12-Bit A/D Converter with Microprocessor Interface (12 pages) |
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| **3582** | HI1176 | 8-Bit, 20MSPS Flash A/D Converter (12 pages) |
| **3666** | HI1179 | 8-Bit, 35MSPS Video A/D Converter (11 pages) |
| **3578** | HI1276 | 8-Bit, 500MSPS Flash A/D Converter (11 pages) |
| **3583** | HI1386 | 8-Bit, 75MSPS Flash A/D Converter (11 pages) |
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# Data Acquisition Product Listing

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| **3286** | HI-5700/ 883 | 8-Bit, 20 MSPS Flash A/D Converter (8 pages) |
| **2937** | HI-5701 | 6-Bit, 30MSPS Flash A/D Converter (14 pages) |
| **3378** | HI-5701/ 883 | 6-Bit, 30 MSPS Flash A/D Converter (8 pages) |
| **3745** | HI5702 | 10-Bit, 40 MSPS A/ D Converter (10 pages) |
| **2938** | HI-5800 | 12-Bit, 3MSPS Sampling A/D Converter (14 pages) |
| **3287** | HI5801 | 12-Bit, 5MSPS A/D Converter (1 page) |
| **3633** | HI5810 | CMOS 10µs 12-Bit Sampling A/D Converter with Internal Track and Hold (13 pages) |
| **3214** | HI5812 | CMOS 12-Bit Sampling A/D Converter with Internal Track and Hold (16 pages) |
| **3634** | HI5813 | CMOS 3.3V, 20µs 12-Bit Sampling A/D Converter with Internal Track and Hold (12 pages) |
| **3373** | HI7131 | 3 1/2 Digit Low Power, High CMRR LCD Display Type A/D Converter (19 pages) |
| **3550** | HI7133 | 3 1/2 Digit Low Power, High CMRR LED Display Type A/D Converter (19 pages) |
| **3099** | HI-7151 | 10-Bit High Speed A/D Converter with Trach and Hold (17 pages) |
| **3100** | HI-7152 | 10-Bit High Speed A/D Converter with Track and Hold (17 pages) |
| **2787** | HI-7153 | 8-Channel, 10-Bit High Speed Sampling A/D Converter (20 pages) |
| **3285** | HI-7153/ 883 | 8-Channel, 10-Bit, High Speed Sampling A/D Converter (12 pages) |
| **3581** | HI20201, HI20203 | 10/8-Bit, 160MSPS Ultra High Speed D/A Converter (12 pages) |
| **3138** | HIN230 thru HIN241 | +5V Powered RS-232 Transmitters/ Receivers (20 pages) |
| **3020** | ICL232 | +5V Powered Dual RS-232 Transmitter/Receiver (8 pages) |
| **3639** | ICL7112 | 12-Bit High-Speed CMOS µP-Compatible A/D Converter (13 pages) |
| **3101** | ICL7115 | 14-Bit High-Speed CMOS µP-Compatible A/D Converter (14 pages) |
| **3112** | ICL7121 | 16-Bit Multiplying Microprocessor-Compatible D/A Converter (7 pages) |

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| **3084** | ICL7126 | 3 $^1/_2$ Digit Low Power Single-Chip A/D Converter (14 pages) |
| **3113** | ICL7134 | 14-Bit Multiplying µP-Compatible D/A Converter (15 pages) |
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| **3182** | ICL766S | CMOS Micropower Over/Under Voltage Detector (13 pages) |
| **3081** | ICL8052/ ICL71C03, ICL8068/ ICL71C03 | Precision 4 $^1/_2$ Digit A/D Converter (21 pages) |
| **3091** | ICL8052/ ICL7104, ICL8068/ ICL7104 | 14/16-Bit µP-Compatible 2-Chip A/D Converter (21 pages) |
| **3163** | ICM7207, ICM7207A | CMOS Timebase Generator (6 pages) |
| **3164** | ICM7208 | 7-Digit LED Display Counter (7 pages) |
| **3128** | IH401A | QUAD Varafet Analog Switch (5 pages) |
| **3129** | IH5009-12 IH5014, IH5016-20 IH5022, IH5024 | Virtual Ground Analog Switch (7 pages) |
| **3134** | IH5341 | Dual SPST CMOS RF/Video Switch (1 page) |
| **3135** | IH5352 | Quad SPST CMOS RF/Video Switch (1 page) |
| **3156** | IH6108 | 8-Channel CMOS Analog Multiplexer (10 pages) |
| **3136** | IH6201 | Dual CMOS Driver/Voltage Translator (5 pages) |
| **3157** | IH6208 | 4-Channel Differential CMOS Analog Multiplexer (8 pages) |
| **DATA ACQUISITION APPLICATION NOTES** | | |
| **9001** | AN001 | Glossary of Data Conversion Terms (6 pages) |
| **9002** | AN002 | Principles of Data Acquisition and Conversion (20 pages) |
| **9004** | AN004 | The IH5009 Analog Switch Series (9 pages) |
| **9009** | AN009 | Pick Sample-Holds by Accuracy and Speed and Keep Hold Capacitors in Mind (7 pages) |
| **9012** | AN012 | Switching Signals with Semiconductors (4 pages) |
| **9016** | AN016 | Selecting A/D Converters (7 pages) |

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| 9017 | AN017 | The Integrating A/D Converter ((5 pages) |
| 9018 | AN018 | Do's and Don'ts of Applying A/D Converters (4 pages) |
| 9020 | AN020 | A Cookbook Approach to High Speed Data Acquisition and Microprocessor Interfacing (23 pages) |
| 9023 | AN023 | Low Cost Digital Panel Meter Designs (5 pages) |
| 9028 | AN028 | Build an Auto-Ranging DMM with the ICL7103A/8052A A/D Converter Pair (6 pages) |
| 9030 | AN030 | ICL7104: A Binary Output A/D Converter for Microprocessors (16 pages) |
| 9032 | AN032 | Understanding the Auto-Zero and Common Mode Performance of the ICL7106/7107/7109 Family (8 pages) |
| 9042 | AN042 | Interpretation of Data Converter Accuracy Specifications (11 pages) |
| 9043 | AN043 | Video Analog-to-Digital Conversion (6 pages) |
| 9046 | AN046 | Building a Battery Operated Auto Ranging DVM with the ICL7106 (5 pages) |
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| 9049 | AN049 | Applying the 7109 A/D Converter (5 pages) |
| 9051 | AN051 | Principles and Applications of the ICL7660 CMOS Voltage Converter (9 pages) |
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| 9054 | AN054 | Display Driver Family Combines Convenience of Use with Microprocessor Interfaceability (18 pages) |
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| 9524 | AN524 | Digital to Analog Converter High Speed ADC Applications (3 pages) |
| 9531 | AN531 | Analog Switch Applications in A/D Data Conversion Systems (4 pages) |
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| 9539 | AN539 | A Monolithic 16-Bit D/A Converter (5 pages) |
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| 9559 | AN559 | HI-222 Video/HF Switch Optimizes Key Parameters (7 pages) |
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| 99316 | AN9316 | Power Supply Considerations for the HI-222 High Frequency Video Switch (2 pages) |
| 99328 | AN9328 | Using the HI1166 Evaluation Board (9 pages) |
| 99329 | AN9329 | Using the HI1176/HI1171 Evaluation Board (5 pages) |

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| **99330** | AN9330 | Using the HI1396 Evaluation Board (9 pages) |
| **99331** | AN9331 | Using the HI1175 Evaluation Board (10 pages) |
| **99332** | AN9332 | Using the HI1276 Evaluation Board (10 pages) |
| **99333** | AN9333 | Using the HI1386 Adapter Board (2 pages) |
| **99336** | AN9336 | Mult-Meter Display Converter Eases DMM Design (6 pages) |
| **99337** | AN9337 | Reduce CMOS-Multiplexer Troubles Through Proper Device Selection (6 pages) |
| **99402** | AN9402 | Keeping the HI-0201 Switch Closed When Removing the V+ Supply (1 page) |

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| **99406** | AN9406 | Using the HI20201/03 Evaluation Kit (11 pages) |
| **99411** | AN9411 | Using the HI1171 Evaluation Kit (6 pages) |
| **DATA ACQUISITION TECH BRIEFS** | | |
| **82322** | TB322 | Replacing an MP7684/MP7684A with an HI5700 (1 page) |
| **82323** | TB323 | Replacing an MP7682 with an HI5701 (1 page) |
| **82324** | TB324 | Clamping the Analog Input of the HI5800 (1 page) |
| **82325** | TB325 | Understanding Glitch in a High Speed D/A Converter (2 pages) |

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**Advanced Tech. Sales**
13755 St. Charles Rock Rd.
Bridgeton, MO 63044
TEL: (314) 291-5003
FAX: 314 291 7958

**NEW JERSEY**
**Harris Semiconductor**
* Plaza 1000 at Main Street
Suite 104
Voorhees, NJ 08043
TEL: (609) 751-3425
FAX: 609 751 5911

**Harris Semiconductor**
724 Route 202
P.O. Box 591
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Building 2A, MS/2T08
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**Nova Marketing**
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Scottsdale, AZ 85260
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Melville, NY 11747
TEL: (516) 391-1300
FAX: 516 391 1644

**Electronics Marketing Corporation (EMC)**
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Columbus, OH 43212
TEL: (614) 299-4161
FAX: 614 299 4121

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Concord, Ontario
Canada L4K 3N6
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**Gerber Electronics**
128 Carnegie Row
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TEL: (617) 769-6000, x156
FAX: 617 762 8931

**Hamilton Hallmark**
10950 W. Washington Blvd.
Culver City, CA 90230
TEL: (310) 558-2000
FAX: 310 558 2809 (Mil)
FAX: 214 343 5988(Com)

**Newark Electronics**
4801 N. Ravenswood
Chicago, IL 60640
TEL: (312) 784-5100
FAX: 312 275-9596

**Wyle Laboratories**
(Commercial Products)
3000 Bowers Avenue
Santa Clara, CA 95051
TEL: (408) 727-2500
FAX: 408 988-2747

**Zeus Electronics, An Arrow Company**
100 Midland Avenue
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FAX: 914 937-2553

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FAX: 407 994-5518

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04077-022 Sao Paulo - SP
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FAX: 55 11 575 7519

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**European Sales Headquarters**
**Harris S.A.**
Mercure Center
100 Rue de la Fusee
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TEL: 32 2 724 21 11
FAX: 32 2 724 2205/...09

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DK - 2200 Copenhagen N
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TEL: 33 1 34 65 40 81 (Dist)
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FAX: 33 1 39 46 40 54
TLX: 697060

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**Harris Semiconductor GmbH**
* Putzbrunnerstrasse 69
81739 München
TEL: 49 89 63813-0
FAX: 49 89 6376201
TWX: 529051
**Harris Semiconductor GmbH**
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TEL: 44 276 686 886
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FAX: 44 942 274732

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A - 1150 Wien
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FAX: 43 1 8941775

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TEL: 43 1 610620
FAX: 43 1 610625

**Spoerle Electronic**
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TWX: 64475

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FAX: 32 2 720 81 52

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FAX: 32 2 215 81 02
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**Ditz Schweitzer A/S**
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TEL: 358 061 318250
FAX: 358 069 22326

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TEL: 358 61 32 22 222
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6/8 rue Ambroise Croizat
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FAX: 33 1 64 47 00 84
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**Arrow Electronique S.A.**
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FAX: 33 1 49 78 05 96
TLX: 265185

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D - 25451 Quickborn
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